Palisades Subbasin

2019 Total Maximum Daily Load and Five-Year Review

Hydrologic Unit Code 17040104

State of Idaho
Department of Environmental Quality
May 2019

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Table of Contents

Executive Summary ix
- Subbasin at a Glance ix
- Key Findings xi
- Public Participation xiv

Introduction 1
- Regulatory Requirements 1

1 Subbasin Characterization 2

2 Water Quality Concerns and Status 6
- 2.1 Water Quality Limited Assessment Units Occurring in the Subbasin 6
- 2.2 Applicable Water Quality Standards and Beneficial Uses 6
- 2.3 Summary and Analysis of Existing Water Quality Data 11

3 Pollutant Source Inventory 23
- 3.1 Point Sources 23
- 3.2 Nonpoint Sources 24
- 3.3 Pollutant Transport 25

4 Summary of Past and Present Pollution Control Efforts and Monitoring 25
- 4.1 5-Year Review of TMDLs 25
- 4.2 Palisades Subbasin Restoration Projects (2011–2017) 29

5 Total Maximum Daily Loads 36
- 5.1 Instream Water Quality Targets 37
- 5.2 Load Capacity 46
- 5.3 Estimates of Existing Pollutant Loads 47
- 5.4 Load Allocation 61
- 5.5 Implementation Strategies 66

6 Conclusions 69

Glossary 75

Appendix A. Beneficial Uses 78

Appendix B. State and Site-Specific Water Quality Standards and Criteria 80

Appendix C. Data Sources 82

Appendix D. Managing Stormwater 123

Appendix E. Pollutant Trading 126

Appendix F. Public Participation and Public Comments 128

Appendix G. Distribution List 129

List of Tables

Table A. 2014 Integrated Report Category 5 listed water bodies. xi
Table B. TMDL prepared with this review. xi
Table C. 2014 Integrated Report Category 4a water bodies addressed by this 5-year review. xii
Table D. Summary of assessment outcomes for assessment units evaluated. xiii
Table 1. Palisades subbasin §303(d)-listed assessment units. 6
Table 2. Palisades subbasin beneficial uses. 8
Table 3. Common numeric criteria supportive of designated beneficial uses in Idaho water quality standards. 9
Table 4. Targets during critical periods for Category 5 assessment units. 10
Table 5. Targets during critical periods for Category 4a assessment units. 10
Table 6. BURP support status results for Palisades subbasin (1993–2015). 13
Table 7. 2017 streambank erosion inventory results. 19
Table 8. Days (number and percentage) exceeding water quality criteria for temperature. 20
Table 9. Rainey Creek E. coli sampling results. 22
Table 10. Solar Pathfinder results for three sites within the Palisades subbasin. 41
Table 11. Bankfull width estimates from regional curves and BURP data for the Palisades subbasin. 43
Table 12. Shade target curves for the vegetation types used in this TMDL. 45
Table 13. Target vs. current solar loads from nonpoint sources in the Palisades subbasin. 46
Table 14. Existing and target solar loads for the 4th-order assessment unit of Fall Creek. 48
Table 15. Existing and target solar loads for the 3rd-order assessment unit of Fall Creek. 49
Table 16. Existing and target solar loads for the 2nd-order assessment unit of Fall Creek. 50
Table 17. Existing and target solar loads for the 4th-order assessment unit of Rainey Creek. 54
Table 18. Total solar loads and average lack of shade for all waters. 61
Table 19. State of Idaho's regulatory authority for nonpoint pollution sources. 65
Table 20. Summary of assessment outcomes for assessment units evaluated. 70
Table B1. Selected numeric criteria supportive of designated beneficial uses in Idaho water quality standards. 80
Table C1. Data sources for Palisades subbasin assessment and TMDL. 82
Table C2. Palisades Predicted Beaver Population—USFS GIS Shapefile Color Symbology (USFS 2012). 83
Table C3. Palisades subbasin 2017 field season streambank erosion inventory locations. 85
Table C4. SEI calculation worksheet for Unnamed Upper Creek—Snake River (ID17040104SK001_02). 86
Table C5. SEI calculation worksheet for Unnamed Lower Creek—Snake River (ID17040104SK001_02). 88
Table C6. SEI calculation worksheet for Antelope Creek (ID17040104SK002_02). 90
Table C7. SEI calculation worksheet for Gibson Creek (ID17040104SK006_02). 92

Table C8. SEI calculation worksheet for Gibson Creek (ID17040104SK006_03). 94
Table C9. SEI calculation worksheet for Lower Fall Creek (ID17040104SK006_04). 96
Table C10. SEI calculation worksheet for Upper Fall Creek II (ID17040104SK006_04). 98
Table C11. SEI calculation worksheet for Indian Creek (ID17040104SK008_02). 100
Table C12. SEI calculation worksheet for Sheep Creek (ID17040104SK008_02). 102
Table C13. SEI calculation worksheet for Bear Creek (ID17040104SK011_04). 104
Table C14. SEI calculation worksheet for Bear Creek (ID17040104SK013_02). 106
Table C15. SEI calculation worksheet for Bear Creek (ID17040104SK013_03). 108
Table C16. SEI calculation worksheet for Indian Creek (ID17040104SK024_04). 110
Table C17. SEI calculation worksheet for Upper Rainey Creek (ID17040104SK028_04). 112
Table C18. SEI calculation worksheet for Lower Rainey Creek (ID17040104SK028_04). 114
Table C19. Temperature logger locations. 116

List of Figures

Figure A. Palisades subbasin—2014 Integrated Report Categories 4a and 5 streams. x
Figure 1. Palisades subbasin water quality status. 5
Figure 2. Cumulative streamflow, Snake River near Alpine, Wyoming (USGS 2017a). 15
Figure 3. Cumulative streamflow, Snake River near Irwin, Idaho (USGS 2017b). 16
Figure 4. Palisades subbasin—2016 predicted beaver population (USFS 2012). 18
Figure 5. Before restoration activities. Source: USFS. 30
Figure 6. After restoration activities. Source: USFS. 30
Figure 7. Aerial view of the Vannoy Farm. Source: USFS. 31
Figure 8. Looking down the valley along Forest Service Road 230 (on the right) at the downcut 3 to 5-foot West Pine Creek. The channel is disconnected from the floodplain and contains limited riparian and wetland habitat (before). Source: USFS. . 32
Figure 9. The stream is now reconnected to the floodplain allowing restoration of the riparian habitat (after). Source: USFS. 33
Figure 10. Old Highway 31 Bridge crossing at West Pine Creek (before). Source: USFS. 33
Figure 11. Newly reconstructed bridge. 33
Figure 12. The stream inundated Red Creek Trail during spring runoff (before). Source: USFS. 34
Figure 13. The trail was removed from the aquatic influence zone and the area restored (after). Source: USFS. 34
Figure 14. The trail runs through the riparian area (before). Source: USFS. 34
Figure 15. The trail was rerouted and riparian area restored (after). Source: USFS. 34
Figure 16. Burns Creek PIT tag antenna receiver. Source: USFS. 36
Figure 17. Burns Creek PIT tag antenna. Source: USFS. 36
Figure 18. Bankfull width as a function of drainage area. 42

Figure 19. BURP bankfull width data as a function of drainage area. 44
Figure 20. Target shade for Fall Creek. 55
Figure 21. Existing shade estimated for Fall Creek by aerial photo interpretation. 56
Figure 22. Shade deficit (difference between existing and target) for Fall Creek. 57
Figure 23. Target shade for Rainey Creek. 58
Figure 24. Existing shade estimated for Rainey Creek by aerial photo interpretation. 59
Figure 25. Shade deficit (difference between existing and target) for Rainey Creek. 60
Figure 26. Palisades subbasin water diversions (IDWR 2018). 63
Figure C1. Record of climatological observations from Weather Station #108937 in Swan Valley, Idaho (NOAA 2017). 84
Figure C2. Temperature data for June Creek at location #Fall C2. 116
Figure C3. Temperature data for Gibson Creek at location #Fall C3. 117
Figure C4. Temperature data for Fall Creek at location #Fall C1. 117
Figure C5. Temperature data for Rainey Creek at location #RC1. 118
Figure C6. Temperature data for Rainey Creek at location #RC2. 118
Figure C7. Temperature data for Rainey Creek at location #RC4. 119
Figure C8. Willow/Graminoid riparian vegetation type #2606. 120
Figure C9. Warm Forest vegetation type #1315. 120
Figure C10. Graminoid/Sagebrush vegetation type. 121
Figure C11. Narrowleaf Cottonwood vegetation type. 121
Figure C12. Quaking Aspen vegetation type. 122
Figure C13. Geyer Willow (Salix geyeriana)/Sedge vegetation type. 122

Abbreviations, Acronyms, and Symbols

§303(d)	refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section
§	section (usually a section of federal or state rules or statutes)
AE	area eroding
AU	assessment unit
BAER	Burn Area Emergency Rehabilitation
BAG	basin advisory group
BLM	United States Bureau of Land Management
BMP	best management practice
BPA	Bonneville Power Administration
BURP	Beneficial Use Reconnaissance Program
C	Celsius
CFR	Code of Federal Regulations (refers to citations in the federal administrative rules)
CGP	Construction General Permit
cfs	cubic feet per second
cfu	colony forming unit
CWA	Clean Water Act
COLD	cold water aquatic life
DEQ	Idaho Department of Environmental Quality
DWS	domestic water supply
E	bank erosion
EPA	United States Environmental Protection Agency
EU	ecological unit
F	Fahrenheit
GIS	geographic information system
IDAPA	refers to citations of Idaho administrative rules
IDFG	Idaho Department of Fish and Game
IPDES	Idaho Pollutant Discharge Elimination System
kWh	kilowatt-hour
LA	load allocation
LC	load capacity
LWCF	Land and Water Conservation Fund

m	meter
mL	milliliter
MOS	margin of safety
MS4	municipal separate storm sewer system
MSGP	Multi-Sector General Permit
N/A	not applicable
NA	not assessed
NB	natural background
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NREL	National Renewable Energy Laboratory
NRCS	Natural Resources Conservation Service
PCR	primary contact recreation
PIT	passive integrated transponder
PNV	potential natural vegetation
R_{LR}	lateral recession rate
SCR	secondary contact recreation
SEI	streambank erosion inventory
SFI	DEQ's Stream Fish Index
SHI	DEQ's Stream Habitat Index
SMI	DEQ's Stream Macroinvertebrate Index
SS	salmonid spawning
SWPPP	Stormwater Pollution Prevention Plan
TBD	to be determined
TMDL	total maximum daily load
TU	Trout Unlimited
US	United States
USFS	United States Forest Service
USGS	United States Geological Survey
WAG	watershed advisory group
WBAG	*Water Body Assessment Guidance*
WLA	wasteload allocation
WRCC	Western Regional Climate Center

Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards).

States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently, this list is published every 2 years as the list of Category 5 water bodies in Idaho's Integrated Report. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses 13 assessment units (AUs) in the Palisades subbasin in Category 4a or 5 of Idaho's most recent federally approved Integrated Report (DEQ 2016a).

This document presents a subbasin assessment and 5-year review (sections 1–4) describing the key physical and biological characteristics of the subbasin, examining the water quality status, extent of impairment, and causes of water quality limitation throughout the Palisades subbasin in eastern Idaho. It also reviews past and ongoing implementation efforts. For more detailed information about the subbasin and previous TMDLs, see the *Palisades Subbasin Assessment and Total Maximum Daily Load Allocations* (DEQ 2001), *Fall Creek Watershed Assessment and Total Maximum Daily Load* (DEQ 2003), and *Palisades Subbasin Total Maximum Daily Loads: 2013 Addendum and Five-Year Review* (DEQ 2015).

The TMDL analyses (section 5) establishes water quality targets and load capacities, estimates existing pollutant loads, and identifies implementation strategies—including reasonable time frames, approach, responsible parties, and monitoring strategies—necessary to achieve load reductions and meet water quality standards.

Subbasin at a Glance

The Palisades subbasin is located midway along the Idaho/Wyoming border, with approximately 10% in Wyoming and 90% in Idaho. The Palisades subbasin (hydrologic unit code 17040104) drains to the South Fork Snake River in eastern Idaho. The Idaho portion of the subbasin contains the Palisades Reservoir Dam and 1,368 stream miles. Management of the Palisades Reservoir regulates the stage and discharge of the South Fork Snake River. Public lands, predominantly forested, cover over two-thirds of the subbasin. The private lands are mainly rural agricultural lands. Previous analyses indicate that water quality issues in the Palisades subbasin are primarily caused by instream erosion and deposition of excess fine sediment.

This document addresses 3 AUs listed in Category 5 (§303(d) list of impaired waters needing a TMDL) and reviews approved TMDLs for 11 AUs listed in Category 4a of *Idaho's 2014 Integrated Report* (DEQ 2016a). Figure A shows streams in Category 4a (pink) and Category 5 (red). The blue stream, which is the Rainey Creek AU (ID17040104SK028_04), is in both categories. This stream has a US Environmental Protection Agency (EPA) approved bacteria

TMDL (Category 4a) but was also listed in Category 5 for combined biota/habitat bioassessments in 2010.

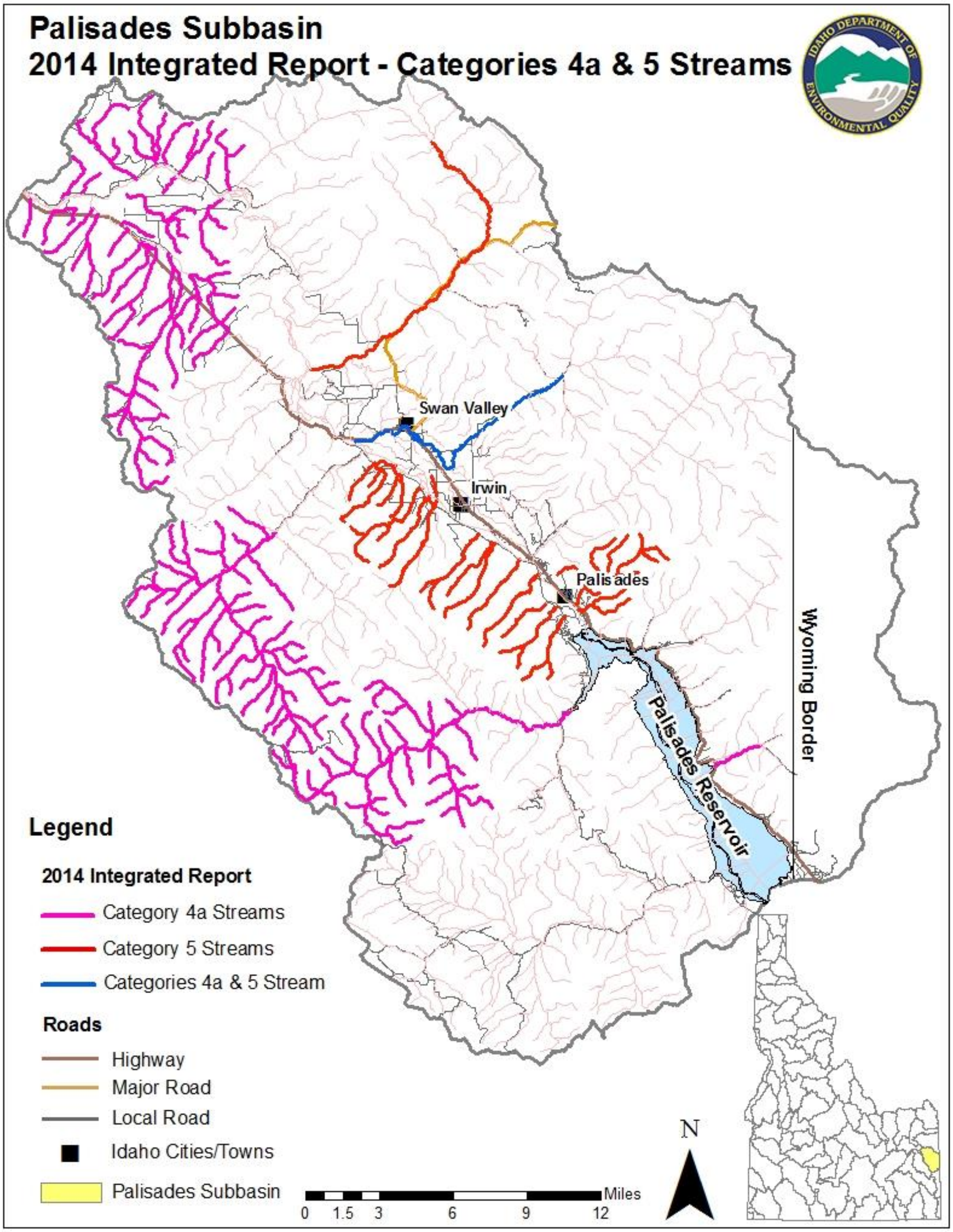

Figure A. Palisades subbasin—2014 Integrated Report Categories 4a and 5 streams.

Key Findings

In the Palisades subbasin, 3 AUs appeared in Category 5 of the 2014 Integrated Report (DEQ 2016a) (Table A).

Table A. 2014 Integrated Report Category 5 listed water bodies.

Assessment Unit Name	Assessment Unit Number	Potential Impairments
Snake River—Palisades Reservoir Dam to Fall Creek	ID17040104SK008_02	Sedimentation/siltation Combined biota/habitat bioassessments
Rainey Creek—source to mouth	ID17040104SK028_04	Combined biota/habitat bioassessments
Pine Creek—source to mouth	ID17040104SK029_03	Cause unknown

Streambank erosion inventories (SEIs) were conducted on Sheep Creek and Indian Creek, tributaries to the Snake River AU (ID17040104SK008_02), and in the upper and mid portions of Rainey Creek (ID17040104SK028_04). SEIs indicated that both AUs met the sediment target of 80% or greater streambank stability.

Pursuant to temperature logger data and application of the PNV approach, excess solar load was determined and temperature was identified as an impairment to Rainey Creek (ID17040104SK028_04). Rainey Creek is not meeting shade targets in lower pasture lands as a result of vegetation removal from grazing. Therefore, a PNV temperature TMDL was developed with this document, as indicated in Table B. Targets for effective shade levels were established for Rainey Creek (ID17040104SK028_04) based on the concept of shading under potential natural vegetation (PNV) conditions resulting in natural background temperature levels. Shade targets were derived from effective shade curves developed for similar vegetation types in Idaho. Once existing shade was determined from aerial photo interpretation, target and existing shade levels were compared to determine the amount of shade needed to bring water bodies into compliance with temperature criteria in Idaho's water quality standards (IDAPA 58.01.02).

Table B. TMDL prepared with this review.

AU Name	AU Number	Confirmed Impairment
Rainey Creek—source to mouth	ID17040104SK028_04	Temperature

The cause of impairment for the Pine Creek AU (ID17040104SK029_03) is unknown. Therefore, further investigation is needed to identify a potential pollutant prior to developing a TMDL.

In addition to evaluating the AUs listed in Category 5 and developing a TMDL, this document contains a 5-year review of 11 AUs with existing approved sediment, temperature, and bacteria TMDLs (Table C). The PNV approach was applied to 3 Fall Creek AUs (ID17040104SK006_02, ID17040104SK006_03, and ID17040104SK006_04). Results from the shade monitoring indicated no excess solar loads. Because they are meeting shade targets, no new TMDLs were developed with this review. Additional surveys are needed to determine beneficial use support in the Fall Creek AUs, but they might be candidates for delisting from Category 4a in a future Integrated Report review cycle.

Bacteria sampling was conducted on Rainey Creek to determine if the AU meets bacteria water quality standards. Results from a five-sample, 30-day geometric mean indicated that bacteria levels were below water quality standards. However, one of the single sample criteria was exceeded; therefore, future sampling will be conducted to determine if this water body is meeting the bacteria water quality standards.

SEIs were conducted on the AUs with sedimentation/siltation impairments listed in Table C, except Antelope Creek (ID17040104SK002_03). This AU was not accessible due to its location on private property. Results from the SEIs indicated that all AUs met the 80% streambank stability target. Table D provides a summary of the assessment outcomes from the 2017 field season for waters listed in Category 4a and Category 5 of the 2014 Integrated Report (DEQ 2016a).

Table C. 2014 Integrated Report Category 4a water bodies addressed by this 5-year review.

AU Name	AU Number	Impairments
Snake River—Black Canyon Creek to river mile 856	ID17040104SK001_02	Sedimentation/siltation
Antelope Creek—source to mouth	ID17040104SK002_02 ID17040104SK002_03	Sedimentation/siltation
Fall Creek—source to South Fork Fall Creek	ID17040104SK006_02 ID17040104SK006_03 ID17040104SK006_04	Sedimentation/siltation Temperature
Bear Creek—North Fork Bear Creek to Palisades Reservoir	ID17040104SK011_04	Sedimentation/siltation
Bear Creek—source to North Fork Bear Creek	ID17040104SK013_02 ID17040104SK013_03	Sedimentation/siltation
Indian Creek—Idaho/Wyoming border to Palisades Reservoir	ID17040104SK024_04	Sedimentation/siltation
Rainey Creek—source to mouth	ID17040104SK028_04	Bacteria (*E. coli*)

Table D. Summary of assessment outcomes for assessment units evaluated.

Assessment Unit Name	Assessment Unit Number	Pollutants	New TMDL Completed	Recommended Changes to Next Integrated Report	Justification
Snake River—Black Canyon Creek to river mile 856	ID17040104SK001_02	Sedimentation/ siltation	No	Keep in Category 4a	AU is meeting TMDL target for sediment; however, additional beneficial use assessments are needed.
Antelope Creek—source to mouth	ID17040104SK002_02	Sedimentation/ siltation	No	Keep in Category 4a	AU is meeting TMDL target for sediment; however, additional beneficial use assessments are needed.
	ID17040104SK002_03	Sedimentation/ siltation	No	Keep in Category 4a	AU was not analyzed. Inaccessible—on private property.
Fall Creek—source to South Fork Fall Creek	ID17040104SK006_02 ID17040104SK006_03 ID17040104SK006_04	Sedimentation/ siltation	No	Keep in Category 4a	AUs are meeting TMDL target for sediment; however, additional beneficial use assessments are needed.
		Temperature	No	Keep in Category 4a	Shade monitoring completed based on PNV. No solar load reductions necessary; however, additional beneficial use assessments are needed.
Snake River—Palisades Reservoir Dam to Fall Creek	ID17040104SK008_02	Combined biota/habitat bioassessments	No	Keep in Category 5	Additional investigation is needed to determine ultimate cause.
		Sedimentation/ siltation	No	Delist from Category 5	Results from SEIs performed for this TMDL and the previous TMDL (DEQ 2015a) indicated AU is meeting sediment targets.
Bear Creek—North Fork Bear Creek to Palisades Reservoir	ID17040104SK011_04	Sedimentation/ siltation	No	Keep in Category 4a	AU is meeting TMDL target for sediment; however, additional beneficial use assessments are needed.
Bear Creek—source to North Fork Bear Creek	ID17040104SK013_02 ID17040104SK013_03	Sedimentation/ siltation	No	Keep in Category 4a	AUs are meeting TMDL target for sediment; however, additional beneficial use assessments are needed.
Indian Creek—Idaho/Wyoming border to Palisades Reservoir	ID17040104SK024_04	Sedimentation/ siltation	No	Keep in Category 4a	AU is meeting TMDL target for sediment; however, additional beneficial use assessments are needed.
Rainey Creek—source to mouth	ID17040104SK028_04	Combined biota/habitat bioassessments	Yes	Delist for combined biota/habitat bioassessments Include in Category 4a for temperature	Temperature replaces combined biota/habitat bioassessments as cause. Temperature TMDL completed based on PNV. Excess solar load from lack of existing shade.
		Escherichia coli (E. coli)	No	Keep in Category 4a	*E. coli* sampling to continue through summer.
Pine Creek—source to mouth	ID17040104SK029_03	Cause unknown	No	Keep in Category 5	AU was not analyzed during this review. Investigation is needed to determine potential cause.

Public Participation

The South Fork Snake Watershed Advisory Group is no longer active and does not intend to reconvene according to the previous chair, Mark Lovell. In the absence of a watershed advisory group, the Upper Snake Basin Advisory Group provided input and supported the start of the public comment period.

DEQ staff also reached out to the following government agencies and non-profits for input during the TMDL process: United States Forest Service (USFS), Idaho Department of Fish and Game (IDFG), United States Bureau of Land Management (BLM), Idaho Idaho Soil and Water Conservation Commission (ISWCC), and Trout Unlimited (TU).

Introduction

This document addresses 13 assessment units (AUs) in the Palisades subbasin that are in Category 4a and/or 5 of the Idaho Department of Environmental Quality's (DEQ's) most recent federally approved Integrated Report: 3 AUs are listed in Category 5 (§303(d) list of impaired waters needing a TMDL) and 11 are listed in Category 4a (have approved TMDLs) (DEQ 2016a). One of the AUs, Rainey Creek (ID17040104SK028_04), is listed in both categories.

The total maximum daily loads (TMDLs) developed for water bodies in Category 5 characterize and document pollutant loads within the subbasin. For water bodies in Category 4a, a 5-year review evaluates the appropriateness of existing TMDLs and associated implementation plans for the subbasin. The first portion of this document presents key characteristics or updated information for the subbasin assessment, which is divided into four major sections: subbasin characterization (section 1), water quality concerns and status (section 2), pollutant source inventory (section 3), and a summary of past and present pollution control efforts, including a 5-year review of existing TMDLs (section 4). While the subbasin assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up to date and accurate.

The subbasin assessment is used to develop a TMDL for each pollutant of concern for the subbasin. The TMDL (section 5) is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (40 CFR Part 130). Consequently, a TMDL is water body- and pollutant-specific. The TMDL also allocates allowable discharges of individual pollutants among the various sources discharging the pollutant. Effective shade targets were established for 4 AUs based on the concept of shading under potential natural vegetation (PNV) resulting in natural background temperatures.

Regulatory Requirements

This document was prepared in compliance with both federal and state regulatory requirements. The federal government, through the United States Environmental Protection Agency (EPA), assumes the dominant role in defining and directing water pollution control programs across the country. DEQ implements the Clean Water Act (CWA) in Idaho, while EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Congress passed the Federal Water Pollution Control Act, more commonly called the CWA, in 1972. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (33 USC §1251). The act and the programs it has generated have changed over the years as experience and perceptions of water quality have changed. The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to ensure "swimmable and fishable" conditions. These goals relate water quality to more than just chemistry.

The CWA requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to §303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. DEQ must review those standards every 3 years, and EPA must approve Idaho's water quality standards. Idaho adopts water quality standards to protect public health and welfare, enhance water quality, and protect biological integrity. A water quality standard defines the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently, this list is published every 2 years as the list of Category 5 waters in Idaho's Integrated Report. For waters identified on this list, states and tribes must develop a TMDL for the pollutants, set at a level to achieve water quality standards.

DEQ monitors waters, and for those not meeting water quality standards must establish a TMDL for each pollutant impairing the waters. However, some conditions that impair water quality do not require TMDLs. EPA considers certain unnatural conditions—such as flow alteration, human-caused lack of flow, or habitat alteration—that are not the result of discharging a specific pollutant as "pollution." TMDLs are not required for water bodies impaired by pollution, rather than a specific pollutant. A TMDL is only required when a pollutant can be identified and in some way quantified.

This document also includes a 5-year review, as required by Idaho Code §39-3611(7) for previously approved TMDLs:

> The director shall review and reevaluate each TMDL, supporting subbasin assessment, implementation plan(s) and all available data periodically at intervals of no greater than five (5) years. Such reviews shall include the assessments required by section 39-3607, Idaho Code, and an evaluation of the water quality criteria, instream targets, pollutant allocations, assumptions and analyses upon which the TMDL and subbasin assessment were based. If the members of the watershed advisory group, with the concurrence of the basin advisory group, advise the director that the water quality standards, the subbasin assessment, or the implementation plan(s) are not attainable or are inappropriate based upon supporting data, the director shall initiate the process or processes to determine whether to make recommended modifications. The director shall report to the legislature annually the results of such reviews.

This document considers the most current and applicable information in conformance with Idaho Code §39-3607, evaluates the appropriateness of the TMDL to current watershed conditions, evaluates the implementation plan, provides for basin advisory group (BAG) input, and evaluates BAG recommendations. The DEQ director makes the final decisions for TMDL modifications. EPA approves TMDL modifications, with DEQ consultation.

1 Subbasin Characterization

The Palisades subbasin, located in eastern Idaho, includes the drainage and tributaries of the South Fork Snake River from Palisades Reservoir at the southeast corner of the watershed, through the communities of Irwin and Swan Valley, to the Heise, Idaho, gaging station. The subbasin (hydrologic unit code 17040104) straddles the Idaho/Wyoming border. The majority of the subbasin (approximately 90%) is in Idaho, and the remainder is in Wyoming. The subbasin is bounded by the Caribou Range to the south and the Big Hole Mountains in the Snake River

Range to the north. The boundary to the northeast is the border between Teton and Bonneville Counties in Idaho. The Idaho portion of the subbasin contains approximately 840 square miles and 1,368 stream miles (DEQ 2001). Elevations in the subbasin range from 5,276 feet in Swan Valley to 10,026 feet at Mount Baird (USGS 1996).

Of the Idaho portion of the Palisades subbasin, almost 90% is in Bonneville County, with small amounts in Madison and Teton Counties. Approximately 97% of Bonneville County is considered *rural*, meaning less than 1,000 people per square mile (US Census Bureau 2017). The rural population density of Bonneville County is approximately 7 persons per square mile. Swan Valley and Irwin are the two main population centers in the subbasin. In 2010, Swan Valley's population was 204 and Irwin's was 219.

Approximately 79% of the subbasin is publically owned and managed by the USFS, BLM, and the State of Idaho. The remaining 21% is privately owned. Primary land uses in the subbasin include forest, agriculture, grazing, range, and recreation. Shrub, rangeland, grass, pasture, or hayland cover 42% of the subbasin; 52% is in forest, water, wetlands, developed, or barren; and 6% is cropland (NRCS 2008). Due to the range of elevations in the subbasin, the vegetation ranges from subalpine fir and Engelmann spruce at the highest elevations to sagebrush communities with grass/forb meadows and mountain brush on the lowest dry slopes. Willow complexes, grasses, and forbs commonly occur along streambanks (TNF 1997; CNF 1999). Species of Salmonidae found in the subbasin include Brown Trout, Brook Trout, Cutthroat Trout, Mountain Whitefish, Rainbow Trout, and Cutthroat Trout–Rainbow Trout hybrids. Bull Trout have not been found in the Palisades subbasin (DEQ 2001).

The climate in the Palisades subbasin is semiarid with cool, moist winters and warm, dry summers. In the winter, the mountains shield the region from extremely cold, dry arctic winds. Winters are cold but not severe. Most of the annual water supply comes from snow that typically falls from late October through early May. During the summer, western winds are weaker and partially blocked from bringing precipitation into lower elevations of the subbasin (Rupert 1994). According to the Western Regional Climate Center (WRCC 2016), between 1947 and 2016, temperatures in Swan Valley and Palisades ranged from 11 °F in the winter to 84 °F in the summer, with the highest temperatures in July and August. Annual average total precipitation during this same timeframe was approximately 18 inches in Swan Valley at the lowest elevation and 19 inches in Palisades. Most of the precipitation in the area occurs in May.

Soils are predominately deep and well-drained, with rapid permeability below the surface. Most of the soils are derived from either coarse gravel-cobble glacial outwash or windblown loess deposits. From Irwin through Swan Valley and along the South Fork floodplain, the soil types belong in the Hobacker-Badgerton Variant. The Hobacker soils comprise the majority of this soil series and have a surface layer of gravelly loam and very gravelly loam, with extremely gravelly sandy loam found at a depth of 30 inches (DEQ 2001).

Mountains associated with overthrust throughout the Caribou Range are composed of hard Mesozoic sedimentary bedrock, mostly limestone, with layers of conglomerate, sandstone, siltstone, and shale. Pliocene rhyolitic flows overlay some of the sedimentary layers in the Caribou Range from Swan Valley up through Antelope Flat to Lookout Mountain. Basalt flows overlap the base of the Caribou Range (Alt and Hyndman 1989). To the north and northeast of the South Fork, the Snake River Range shows very old Paleozoic formations. The Big Hole

Range contains both Mesozoic and Paleozoic formations. The valley flats between the ranges consist predominately of Tertiary valley-fill sediments in Swan Valley and Snake River plain basalt flows downstream through the Antelope Flat region (DEQ 2001).

In 1956, the Palisades dam and reservoir were built for irrigation storage. The reservoir has a capacity of 1.2 million acre feet (DEQ 2001). Water supply and demand are affected by weather, storage holdover, and water rights, so any analysis of average annual streamflow will not indicate natural hydrological trends for the South Fork (BLM and TNF 1990). Management of the Palisades Reservoir regulates the water level and volume of the South Fork Snake River. Managing the water level and volume allow flows to be controlled during the year, including peak flows that would normally be a source of flooding in the late spring and summer. Tributary flows are dependent on seasonal weather patterns and snowmelt and the highest flow rates in the tributaries occur in the spring as a result of the snowmelt and then taper off during the summer. Additional subbasin characterization details can be found in the *Palisades Subbasin Assessment and Total Maximum Daily Load Allocations* (DEQ 2001).

Figure 1 provides an overview of the 2014 Integrated Report (DEQ 2016a) water quality status of the Palisades subbasin. Categories 4a and 5, shown in red and labeled as *Not Supporting*, are the focus of this document.

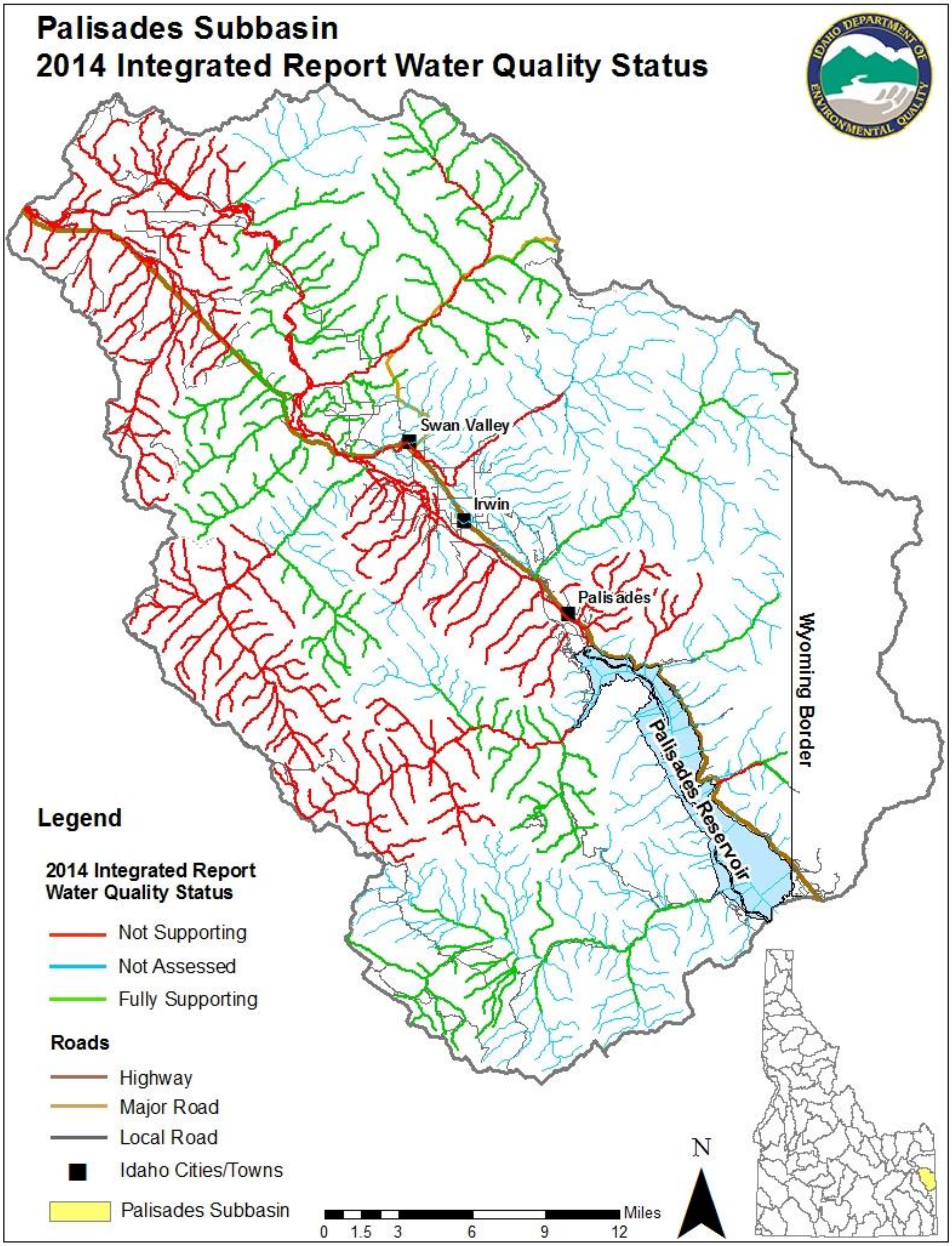

Figure 1. Palisades subbasin water quality status.

2 Water Quality Concerns and Status

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

Section 303(d) of the CWA states that waters that are unable to support their beneficial uses and do not meet water quality standards must be listed as water quality limited. Subsequently, these waters are required to have TMDLs developed to bring them into compliance with water quality standards.

2.1.1 Assessment Units

AUs are a subdivision of water body units, which allow them to relate directly to the water quality standards. An AU is a group of similar streams that have similar land use practices, ownership, or land management. However, stream order is the main basis for determining AUs—even if ownership and land use change significantly, the AU usually remains the same for the same stream order.

Using AUs as a basis for assessments and TMDLs offers the benefit of being more precise so that all waters of the state are defined consistently.

2.1.2 Listed Waters

Table 1 shows the pollutants and the basis for listing for each §303(d)-listed AU in the subbasin (i.e., AUs in Category 5 of the 2014 Integrated Report [DEQ 2016a]).

Table 1. Palisades subbasin §303(d)-listed assessment units.

Assessment Unit Name	Assessment Unit Number	Listed Pollutants	Integrated Report §303(d) Listings
Snake River—Palisades Reservoir Dam to Fall Creek	ID17040104SK008_02	Combined biota/habitat bioassessments	1998
		Sedimentation/siltation	2008
Rainey Creek—source to mouth	ID17040104SK028_04	*E. coli*	2002
		Combined biota/habitat bioassessments	2010
Pine Creek—source to mouth	ID17040104SK029_03	Cause unknown	2008

2.2 Applicable Water Quality Standards and Beneficial Uses

Idaho water quality standards (IDAPA 58.01.02) list beneficial uses and set water quality goals for waters of the state. Idaho water quality standards require that surface waters of the state be protected for beneficial uses, including recreational use and the preservation and propagation of aquatic life wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are also classified as existing, designated, and presumed uses (see Appendix A). The *Water Body Assessment Guidance* or WBAG (DEQ 2016b) provides a more detailed description of beneficial use identification for use assessment purposes.

Beneficial uses include the following in Idaho's water quality standards:

- Aquatic life support—cold water, seasonal cold water, warm water, salmonid spawning, and modified
- Contact recreation—primary (e.g., swimming) or secondary (e.g., boating)
- Water supply—domestic, agricultural, and industrial
- Wildlife habitats
- Aesthetics

2.2.1 Beneficial Uses in the Subbasin

Table 2 lists the beneficial uses within the Palisades subbasin AUs addressed in this document and whether they are designated or existing. Beneficial uses include the following:

- Cold water aquatic life (COLD)—Applies to water quality appropriate for protecting and maintaining a viable aquatic life community for coldwater species.
- Salmonid spawning (SS)—Applies to waters that provide or could provide a habitat for active selfpropagating populations of salmonid fishes.
- Primary contact recreation (PCR)—Applies to waters where people engage in activities that involve immersion in and likely ingestion of water. Examples of these activities include swimming, waterskiing, and skin diving.
- Secondary contact recreation (SCR)—Applies to waters where people engage in activities in which ingestion of water may occasionally occur. Examples of these activities include fishing, boating, wading, and infrequent swimming.
- Domestic water supply (DWS)—Applies to water quality appropriate for drinking water supplies.

The beneficial uses of most of the AUs in the Palisades subbasin are cold water aquatic life and secondary contact recreation. Domestic water supply use has only been applied to the Snake River AUs (ID17040104SK001_02 and ID17040104SK008_02), which are also the only AUs with designated uses.

Existing uses under the CWA are "those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards." Designated uses are specifically listed for Idaho water bodies in the Idaho water quality standards (IDAPA 58.01.02).

See the *Palisades Subbasin Assessment and Total Maximum Daily Load Allocations* (DEQ 2001) for more detailed information on the beneficial uses in the subbasin.

Table 2. Palisades subbasin beneficial uses.

Assessment Unit Name	Assessment Unit Number and Water Bodies Included	Beneficial Uses	Type of Use
Snake River—Black Canyon Creek to river mile 856	ID17040104SK001_02 -Mud Creek -Spring Creek -Wolverine Creek -Woods Creek	COLD, SS, PCR, DWS	Designated
Antelope Creek—source to mouth	ID17040104SK002_02 -Antelope Creek -Little Pine Creek -Trail Creek	COLD, SS, SCR	Existing
Antelope Creek—source to mouth	ID17040104SK002_03	COLD, SCR	Existing
Fall Creek—source to South Fork Fall Creek	ID17040104SK006_02 -Bates Creek -Beaver Creek -Camp Creek -East Fork Fall Creek -Fall Creek -Gibson Creek -Haskin Creek -June Creek -Monument Creek -Porcupine Creek -Sawmill Creek -Trap Creek -Willow Springs Creek	COLD, SS, SCR	Existing
Fall Creek—source to South Fork Fall Creek	ID17040104SK006_03 -East Fork Fall Creek -Fall Creek -Gibson Creek	COLD, SS, SCR	Existing
Fall Creek—source to South Fork Fall Creek	ID17040104SK006_04	COLD, SS, SCR	Existing
Snake River—Palisades Reservoir Dam to Fall Creek	ID17040104SK008_02 -Deer Creek -Dry Gulch Creek -Indian Creek -Little Sheep Creek -Papoose Creek -Russell Creek -Sawmill Canyon Creek -Sheep Creek -Squaw Creek -Tag Alder Creek -Yeaman Creek	COLD, SS, PCR, DWS	Designated
Bear Creek—North Fork Bear Creek to Palisades Reservoir	ID17040104SK011_04	COLD, SS, SCR	Existing
Bear Creek—source to North Fork Bear Creek	ID17040104SK013_02 -Bear Creek -Chaparral Creek -Deadman Creek -South Fork Bear Creek -Warm Springs Creek	COLD, SS, SCR	Existing
Bear Creek—source to North Fork Bear Creek	ID17040104SK013_03	COLD, SS, SCR	Existing
Indian Creek—Idaho/Wyoming border to Palisades Reservoir	ID17040104SK024_04	COLD, SCR	Existing
Rainey Creek—source to mouth	ID17040104SK028_04	COLD, SS, SCR	Existing
Pine Creek—source to mouth	ID17040104SK029_03	COLD, SS, SCR	Existing

Notes: Cold water aquatic life (COLD), domestic water supply (DWS), primary contact recreation (PCR), salmonid spawning (SS), secondary contact recreation (SCR)

2.2.2 Water Quality Criteria to Support Beneficial Uses

Beneficial uses are protected by a set of water quality criteria, which include numeric criteria for pollutants such as bacteria, dissolved oxygen, pH, ammonia, temperature, and turbidity

(Appendix B), and narrative criteria for pollutants such as sediment and nutrients (IDAPA 58.01.02.250–251). For more about temperature criteria and natural background provisions relevant to the PNV approach, see Appendix B.

Narrative criteria for excess sediment are described in the water quality standards:

> Sediment shall not exceed quantities specified in Sections 250 and 252, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Subsection 350. (IDAPA 58.01.02.200.08)

Table 3 includes the most common numeric criteria for bacteria and temperature used in TMDLs.

Table 3. Common numeric criteria supportive of designated beneficial uses in Idaho water quality standards.

Parameter	Primary Contact Recreation	Secondary Contact Recreation	Cold Water Aquatic Life	Salmonid Spawning[a]
Water Quality Standards: IDAPA 58.01.02.250				
Bacteria	<126 *E. coli*/100 mL[b] as a geometric mean of 5 samples over 30 days	<126 *E. coli*/100 mL as a geometric mean of 5 samples over 30 days	—	—
Temperature[c]	—	—	22 °C or less daily maximum; 19 °C or less daily average **Seasonal Cold Water:** Between summer solstice and autumn equinox: 26 °C or less daily maximum; 23 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average

[a] During spawning and incubation periods for inhabiting species
[b] *Escherichia coli* per 100 milliliters
[c] Temperature Exemption: Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the 90th percentile of the 7-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.

DEQ's procedure to determine whether a water body fully supports designated and existing beneficial uses is outlined in IDAPA 58.01.02.050.02. The procedure relies heavily on biological parameters and is presented in detail in the WBAG (DEQ 2016b). This guidance requires DEQ to use the most complete data available to make beneficial use support status determinations.

Table 4 and Table 5 provide the most critical time of the year for the AUs in Categories 4a and 5 of the 2014 Integrated Report (DEQ 2016a) to meet the water quality targets associated with their respective impairments. For example, Rainey Creek (ID17040104SK028_04) was listed in Category 5 for combined biota/habitat bioassessments. The 2017 streambank erosion inventory (SEI), temperature logger, and PNV investigations showed the impairment is temperature. The temperature targets for two of the beneficial uses assigned to Rainey Creek are 22 °C daily maximum and 19 °C daily average for cold water aquatic life and 13 °C daily maximum and

9 °C daily average for salmonid spawning. Critical periods are July 15–August 15 (the warmest time of year) for cold water aquatic life. The critical period for salmonid spawning is dependent on the type(s) of salmonid observed in a stream. For Rainey Creek, this critical period is October 1–July 15 due to the observed presence of Yellowstone Cutthroat Trout, Brown Trout, Brook Trout, Rainbow Trout, and Mountain Whitefish during electrofishing (DEQ 2001; IDFG 2015; USFS 1997-2012). If the temperature criteria are met during these critical times, temperature would not be considered an impairment to the AU.

For AUs with sedimentation/siltation impairments, the 80% streambank stability target is year-round. For AUs with *E. coli* impairment, numeric criteria applies in lieu of target criteria. The critical period is May–October, which coincides with grazing season and the peak recreation season.

Two AUs listed in Table 4 and Table 5 were not evaluated in this document: Pine Creek (AU ID17040104SK029_03) and Antelope Creek (AU ID17040104SK002_03). The cause of impairment for the Pine Creek AU is unknown. Further investigations are needed to confirm if an impairment currently exists. Until confirmation, this AU will remain in Category 5. The Antelope Creek AU was not evaluated in this document due to its inaccessible location on private property and will remain in Category 4a.

Table 4. Targets during critical periods for Category 5 assessment units.

Assessment Unit Name	Assessment Unit Number	Listed Impairments	Confirmed Impairments	Target	Critical Period	TMDL Approval Date
Snake River—Palisades Reservoir Dam to Fall Creek	ID17040104SK008_02	Combined biota/habitat bioassessments	TBD	TBD	TBD	TBD
		Sedimentation/ siltation	N/A	N/A	N/A	TBD
Rainey Creek—source to mouth	ID17040104SK028_04	Combined biota/habitat bioassessments	Temperature	COLD: 22 °C daily maximum; 19 °C daily average	Jul 15–Aug 15	TBD
				SS: 13 °C daily maximum; 9 °C daily average	Oct 1–July 15	
Pine Creek—source to mouth	ID17040104SK029_03	Cause Unknown	TBD	N/A	N/A	TBD

Notes: cold water aquatic life (COLD); not applicable (N/A); salmonid spawning (SS); to be determined (TBD)

Table 5. Targets during critical periods for Category 4a assessment units.

Assessment Unit Name	Assessment Unit Number	Impairments	Numeric Criteria	Target	Critical Period	TMDL Approval Date
Snake River—Black Canyon Creek to river mile 856	ID17040104SK001_02	Sedimentation/ siltation	N/A	80% streambank stability	Year-round	02/10/14
Antelope Creek—source to mouth	ID17040104SK002_02	Sedimentation/ siltation	N/A	80% streambank stability	Year-round	02/20/01
Antelope Creek—source to mouth	ID17040104SK002_03	Sedimentation/ siltation	N/A	80% streambank stability	Year-round	02/20/01
Fall Creek—source to South Fork Fall Creek	ID17040104SK006_02	Sedimentation/ siltation	N/A	80% streambank stability	Year-round	04/08/04

Assessment Unit Name	Assessment Unit Number	Impairments	Numeric Criteria	Target	Critical Period	TMDL Approval Date
		Temperature		COLD: 22 °C daily maximum; 19 °C daily average	Jul 15–Aug 15	
				SS: 13 °C daily maximum; 9 °C daily average	May 1–Jul 15 and Oct 1–Oct 31	
Fall Creek—source to South Fork Fall Creek	ID17040104SK006_03	Sedimentation/ siltation	N/A	80% streambank stability	Year-round	04/08/04
		Temperature		COLD: 22 °C daily maximum; 19 °C daily average	Jul 15–Aug 15	
				SS: 13 °C daily maximum; 9 °C daily average	May 1–Jul 15 and Oct 1–Oct 31	
Fall Creek—source to South Fork Fall Creek	ID17040104SK006_04	Sedimentation/ siltation	N/A	80% streambank stability	Year-round	04/08/04
		Temperature		COLD: 22 °C daily maximum; 19 °C daily average	Jul 15–Aug 15	
				SS: 13 °C daily maximum; 9 °C daily average	May 1–Jul 15 and Oct 1–Oct 31	
Bear Creek—North Fork Bear Creek to Palisades Reservoir	ID17040104SK011_04	Sedimentation/ siltation	N/A	80% streambank stability	Year-round	02/20/01
Bear Creek—source to North Fork Bear Creek	ID17040104SK013_02	Sedimentation/ siltation	N/A	80% streambank stability	Year-round	02/20/01
Bear Creek—source to North Fork Bear Creek	ID17040104SK013_03	Sedimentation/ siltation	N/A	80% streambank stability	Year-round	02/20/01
Indian Creek—Idaho/Wyoming border to Palisades Reservoir	ID17040104SK024_04	Sedimentation/ siltation	N/A	80% streambank stability	Year-round	02/10/14
Rainey Creek—source to mouth	ID17040104SK028_04	*Escherichia coli*	<126 cfu/100 mL (geometric mean)	N/A	May 1–Oct 31	02/10/14

Notes: cold water aquatic life (COLD); colony forming units per 100 milliliters (cfu/100 mL); not applicable (N/A); salmonid spawning (SS); to be determined (TBD)

2.3 Summary and Analysis of Existing Water Quality Data

Water quality data were examined and collected to evaluate sediment, temperature, and bacteria impairments. This data was then analyzed to establish the current water quality status of the water bodies and compared to data gathered for the previous Palisades subbasin TMDLs (DEQ 2001, DEQ 2003, DEQ 2015a).

2.3.1 Beneficial Use Reconnaissance Program Data

The Beneficial Use Reconnaissance Program (BURP) monitoring protocol uses standardized procedures to collect aquatic insects, conduct fish surveys, measure water chemistry, and document habitat conditions in streams and rivers to determine beneficial use support. Aquatic insects and fish are sensitive to changes in water quality, so their presence, abundance, and health serve as indicators of the overall quality of a water body. BURP data are evaluated against Idaho's water quality standards using Idaho's WBAG (DEQ 2016b) to determine if the water body is meeting standards and supporting beneficial uses.

Table 6 provides the BURP data related to the cold water aquatic life and salmonid spawning beneficial use support that were evaluated with this review. The BURP monitoring protocol provides data on three important stream quality indicators: macroinvertebrates, fish, and habitat. A stream macroinvertebrate index (SMI) is generated from seven different qualities of the macroinvertebrates found, including species diversity, richness of species diversity, species guilds, and pollutant tolerance. A stream fish index (SFI) is developed based on species present, abundance of the different species, and presence/absence of juveniles. A stream habitat index (SHI) uses both quantitative and qualitative measures of stream habitat, including substrate composition, channel structure, streamside vegetation, and streambank condition. Index scores (condition ratings) from the monitoring samples are compared with statistical reference index scores and used along with available physical and chemical data to determine whether an AU supports its beneficial uses. A score of 0 or 1 is not supporting and a score of 2 or 3 is considered fully supporting.

Establishing water quality trends within the Palisades subbasin using BURP data is a challenge due to intermittent dry conditions and infrequent BURP monitoring in previous years at most sites. Of the 13 AUs addressed in this document, BURP monitoring was completed on 4 AUs (Bear Creek ID17040104SK011_04, Indian Creek ID17040104SK024_04, Rainey Creek ID17040104SK028_04, and Pine Creek ID17040104SK029_03) within the last 5 years. The 2015 BURP results for Indian Creek noted the water was turbid, with large amounts of sediment and clay on the streambed and the resulting high Wolman pebble count scores indicated a highly embedded stream reach. However, elevated sediment levels were not observed at this AU or other AUs in the Palisades subbasin during the 2017 field season. High flow events in 2016 and 2017 may have flushed some of the silts and sediment out of the AUs where elevated sediment levels were observed and documented in previous years.

Table 6. BURP support status results for Palisades subbasin (1993–2015).

Assessment Unit Name	Assessment Unit Number	Year	SMI	SFI	SHI	Average	2014 Integrated Report Category
Snake River—Black Canyon Creek to river mile 856	ID17040104SK001_02	2006	—	—	—	NA–Dry	4a
		1997	3	—	1	2.00	
		1996	2	—	1	1.50	
Antelope Creek—source to mouth	ID17040104SK002_02	2001	—	—	—	NA–Dry	4a
		1995	0	—	1	0.00	
		1994	2	—	1	1.50	
	ID17040104SK002_03	2007	—	—	—	NA–Dry	4a
		2001	—	—	—	NA–Dry	
Fall Creek—source to South Fork Fall Creek	ID17040104SK006_02	2010	1	2	1	1.33	4a
		2008	—	—	—	NA–Dry	
		2001	—	—	—	NA–Dry	
		2001	—	—	—	NA–Dry	
		1996	0	—	3	0.00	
		1996	3	3	1	2.33	
		1996	—	—	—	NA–Dry	
		1996	—	—	—	NA–Dry	
		1996	0	—	1	0.00	
		1996	3	—	3	3.00	
		1996	0	—	3	0.00	
	ID17040104SK006_03	2001	—	—	—	NA–Dry	4a
	ID17040104SK006_04	2001	3	0	1	0.00	4a
		1996	0	—	1	0.00	
		1993	1	—	1	1.00	
Snake River—Palisades Reservoir Dam to Fall Creek	ID17040104SK008_02	2001	1	—	1	1.00	5
		1996	0	—	1	0.00	
		1996	0	—	1	0.00	
		1996	3	—	3	3.00	
		1996	0	—	1	0.00	
		1996	1	2	3	2.00	
		1996	2	—	3	2.50	
		1996	2	—	3	2.50	
		1996	0	—	3	0.00	
		1996	0	—	3	0.00	
Bear Creek—North Fork Bear Creek to Palisades Reservoir	ID17040104SK011_04	2015[a]	1	1	2	1.33	4a
		2001	3	0	3	0.00	
		1996	3	1	3	2.33	
Bear Creek—source to North Fork Bear Creek	ID17040104SK013_02	2001	3	3	2	2.67	4a
		1996	—	—	—	NA–Dry	
		1996	1	—	1	1.00	
	ID17040104SK013_03	2007	—	—	—	NA–Dry	4a

Assessment Unit Name	Assessment Unit Number	Year	SMI	SFI	SHI	Average	2014 Integrated Report Category
Indian Creek—Idaho/Wyoming border to Palisades Reservoir	ID17040104SK024_04	2015[a]	1	—	1	1.00	4a
		1998	1	—	1	1.00	
Rainey Creek—source to mouth	ID17040104SK028_04	2013[a]	3	1	3	2.33	4a, 5
		2008	3	2	2	2.33	
		1998	1	1	1	1.00	
		1996	3	2	2	2.33	
		1993	—	—	1	1.00	
		1993	3	—	1	2.00	
Pine Creek—source to mouth	ID17040104SK029_03	2015[a]	—	—	—	NA–Dry	5
		2004	—	—	—	NA–Dry	
		2004	2	—	2	2.00	
		2001	3	1	3	2.33	
		1996	3	3	1	2.33	
		1993	3	—	1	2.00	

Notes: not assessed (N/A or —), stream fish index (SFI), stream habitat index (SHI), stream macroinvertebrate index (SMI)
[a] Scores shown in this table are calculated with the 2002 version of the WBAG (Grafe et al. 2002). For Integrated Report cycles 2016 and beyond, the updated 2016 version of the WBAG (DEQ 2016b) will be used for assessments on these AUs.

2.3.2 Streambank Erosion Inventory Data

According to the *Palisades Subbasin Total Maximum Daily Loads: 2013 Addendum and Five-Year Review* (DEQ 2015a), erosion in the Palisades subbasin is primarily due to unstable streambanks rather than upland erosion. Streambank erosion was found to be the most significant source of pollution over other sources, including dirt roads, erosion from cultivated fields, and stormwater runoff. As streambanks erode, they become less stable and especially vulnerable during high velocity flows that typically occur with spring runoff. The 2017 spring runoff was above average due to the amount of snow the subbasin received. US Geological Survey (USGS) gage station data (USGS 2017a,b) revealed that gages located along the Snake River above and below the Palisades Reservoir recorded higher than usual flow rates in 2017. In December 2017, USGS gage station 13022500 on the Snake River above the Palisades Reservoir near Alpine, Wyoming, recorded cumulative streamflow of approximately 2.9 million cubic feet per second (cfs) compared to a cumulative daily median of approximately 2 million cfs. USGS gage station 13032500 on the Snake River near Irwin, which is at the bottom of the valley, recorded cumulative streamflow of approximately 3.5 million cfs compared to a cumulative daily median of approximately 2.5 million cfs. In 2017, both of these stations recorded the highest streamflow since 1997, which is noted on USGS hydrographs as the highest observed cumulative flow rate year (Figure 2; Figure 3).

Even with the increased flow rate, streambank erosion rates were considered normal for these types of water bodies. The favorable SEI results are likely from the numerous beaver dams encountered along the AUs during the SEIs. Beaver activity was noted in the lower portion of Rainey Creek during the inventories; however, beaver dams were particularly prevalent in the Fall Creek, Bear Creek, and Antelope Creek AUs. Beavers may be abundant in the Palisades subbasin due to their preference for food from the genera Populus and Salix (i.e., aspen, cottonwood, and willows) (Pollock et al. 2017), which make up the majority of the Palisades subbasin vegetation. Willow complexes, grasses, and forbs outnumber all other plants on the streambanks, and extensive cottonwood riparian areas line the river bottoms. Aspen, pure Douglas-fir, or pure lodgepole pine each account for about 15% of forests in the Palisades subbasin (DEQ 2001).

The SEI locations for these streams were modified in the field to avoid beaver activity. SEIs should not be conducted in the direct vicinity of beaver dams because hydrologic stream conditions altered by beaver presence may not be representative of the entire AU. However, research shows that beavers improve the riverine ecosystem by creating higher water tables, reconnecting floodplains, and expanding wetlands, which increases habitat complexity and improves water quality for plants, fish, and wildlife (Pollock et al. 2017).

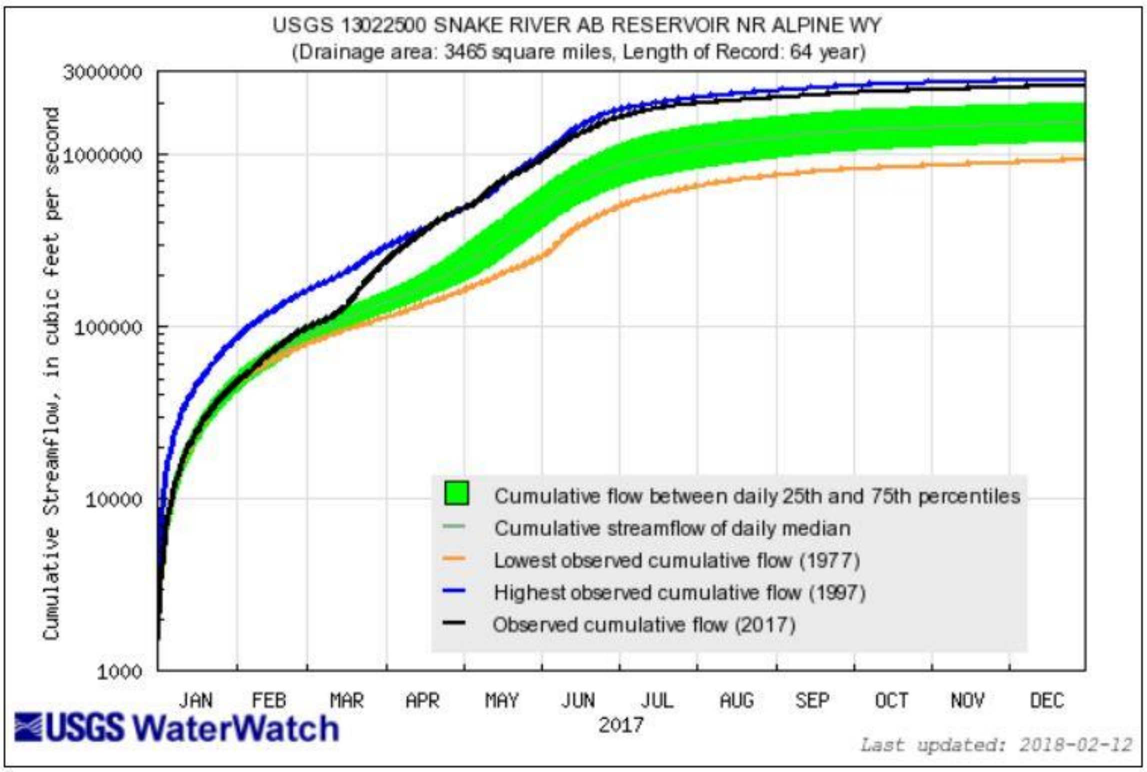

Figure 2. Cumulative streamflow, Snake River near Alpine, Wyoming (USGS 2017a).

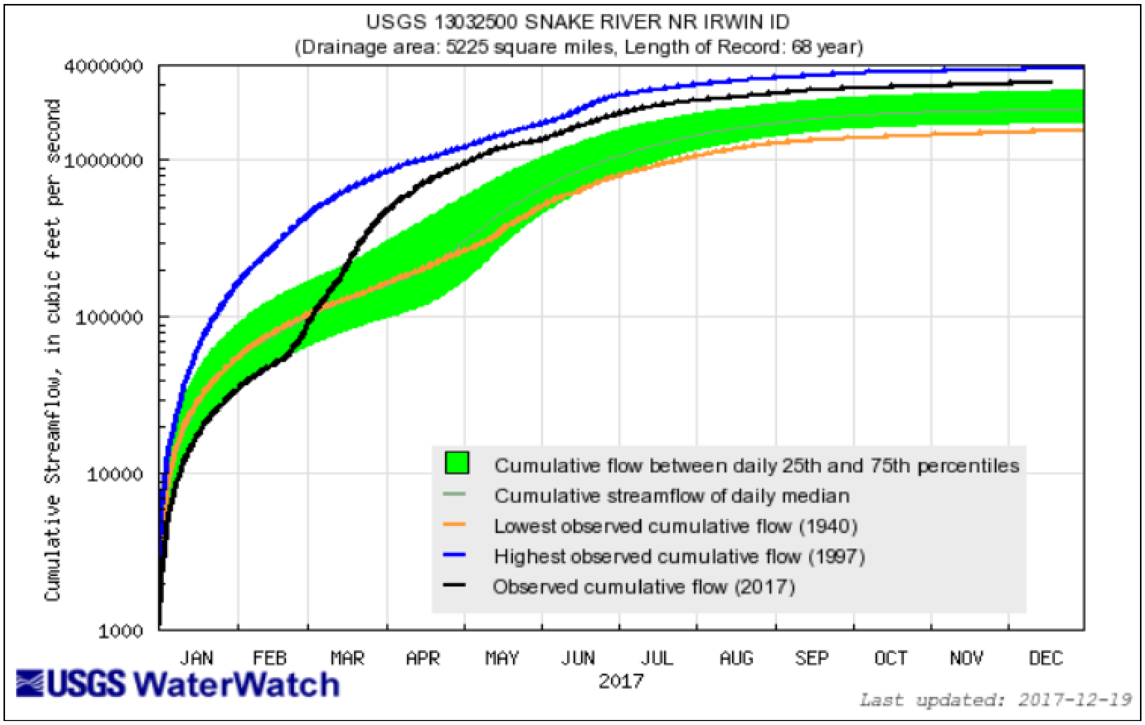

Figure 3. Cumulative streamflow, Snake River near Irwin, Idaho (USGS 2017b).

Figure 4 shows the presumed status of beaver activity within the Palisades subbasin. This analysis by the USFS used GIS modeling and aerial imagery review. The modeling process identified streams containing (1) gradients <12%; (2) mid-level vegetation including conifer/aspen, riparian shrublands, and deciduous forest within 100 meters of streams; and (3) tree canopy coverage ranging from 30% to 70% and shrub canopy coverage ranging from 25% to approximately 50%. No actual ground observations took place for the review, but the information gathered by the USFS coincides with the locations where beaver activity was noted while conducting the 2017 fieldwork. Appendix C (Table C2) contains further details on the meanings and symbology of the colored creek segments shown on Figure 4 (USFS 2012).

The SEI is used to measure streambank stability by estimating erosion rates and sediment loads into streams. SEI is a qualitative evaluation of channel shape, streambank stability, and riparian vegetation developed using field methods outlined by the Natural Resources Conservation Service (NRCS) as a tool to evaluate erosion condition on streambanks, gullies, and roads (NRCS 1983). When an eroding streambank is identified in the field during an SEI, the streambank height and length are measured and recorded. Six streambank characteristics are ranked in the field, and corresponding erosion rates and target erosion rates are calculated using a spreadsheet. Streambank erosion values obtained from the sample reach can be extrapolated to adjacent streambanks of similar condition with the same land uses to estimate direct annual sediment inputs to the stream. Streambank erosion up to 20% is considered a natural phenomenon, so when streambank stability is at 80%, load capacity is considered met (Overton et al. 1995).

A total of 15 SEIs were conducted on 11 AUs. In some cases, two different locations within the same AU were surveyed. Out of 11 AUs, 9 were surveyed as part of the 5-year review process and the ongoing monitoring of existing sediment TMDLs. The tenth AU was listed in Category 5 as impaired by sediment and combined biota/habitat bioassessments (Snake River AU ID17040104SK008_02). The eleventh AU (Rainey Creek AU ID17040104SK028_04) was listed as impaired by combined biota/habitat bioassessments. Antelope Creek (AU ID17040104SK002_03) is the only Category 4a AU with sediment-caused impairments where an SEI was not conducted in 2017. This AU is inaccessible due to its location on private property. Appendix C provides coordinates of the SEI locations evaluated during the 2017 field season.

Table 7 summarizes current sediment loads and load capacities in tons per year and compares 2017 streambank stability results to past SEI or TMDL targets. All AUs met the 80% streambank stability target. The riparian community on the majority of the AUs where the 2017 SEIs were conducted appeared vibrant and healthy along the streambanks and therefore supported the SEI results. Due to the variability in the SEI process (e.g., data collection, dimensions of areas surveyed), load capacities for this review were based on 2017 SEI methodology and determined by calculating the sediment load to the stream from eroding streambanks when 80% of the banks are stable with no erosion (natural condition or load capacity) and under current bank conditions. For Rainey Creek (ID17040104SK028_04), no value appears in Table 7 for comparison because a sediment TMDL has never been prepared for this AU.

Since the previous SEIs have been conducted or previous TMDLs have been developed, several improvements have been made to the streambank stability percentages in the following AUs:

- Fall Creek (ID17040104SK006_02, ID17040104SK006_03, and ID17040104SK006_04)
- Bear Creek (ID17040104SK011_04, ID17040104SK013_02, and ID17040104SK013_03)
- Antelope Creek (ID17040104SK002_02)
- Snake River (ID17040104SK001_02)

Although the SEIs confirmed sediment loads are improving in these AUs, further investigations are required to delist these water bodies.

The 2017 SEI results from Indian Creek and Sheep Creek within the Snake River AU (ID17040104SK008_02) indicated the AU met the streambank stability target of 80%. The streambank stability for both streams was 85% even though 2017 was the highest flow year since 1997 (Table 7). The 80% streambank stability target was also met when SEIs were performed in 2010 on Indian Creek and Squaw Creek for the previous TMDL (DEQ 2015a). The SEI data collected in 2010 indicated the streambank stability was 92% for Indian Creek and 100% for Squaw Creek. Because streambank stability targets were met within a span of 7 years, this AU is recommended for delisting from Category 5 for sedimentation/siltation. It should remain in Category 5 for combined biota/habitat bioassessments until the ultimate cause can be identified. The SEI worksheets for each AU are located in Appendix C.

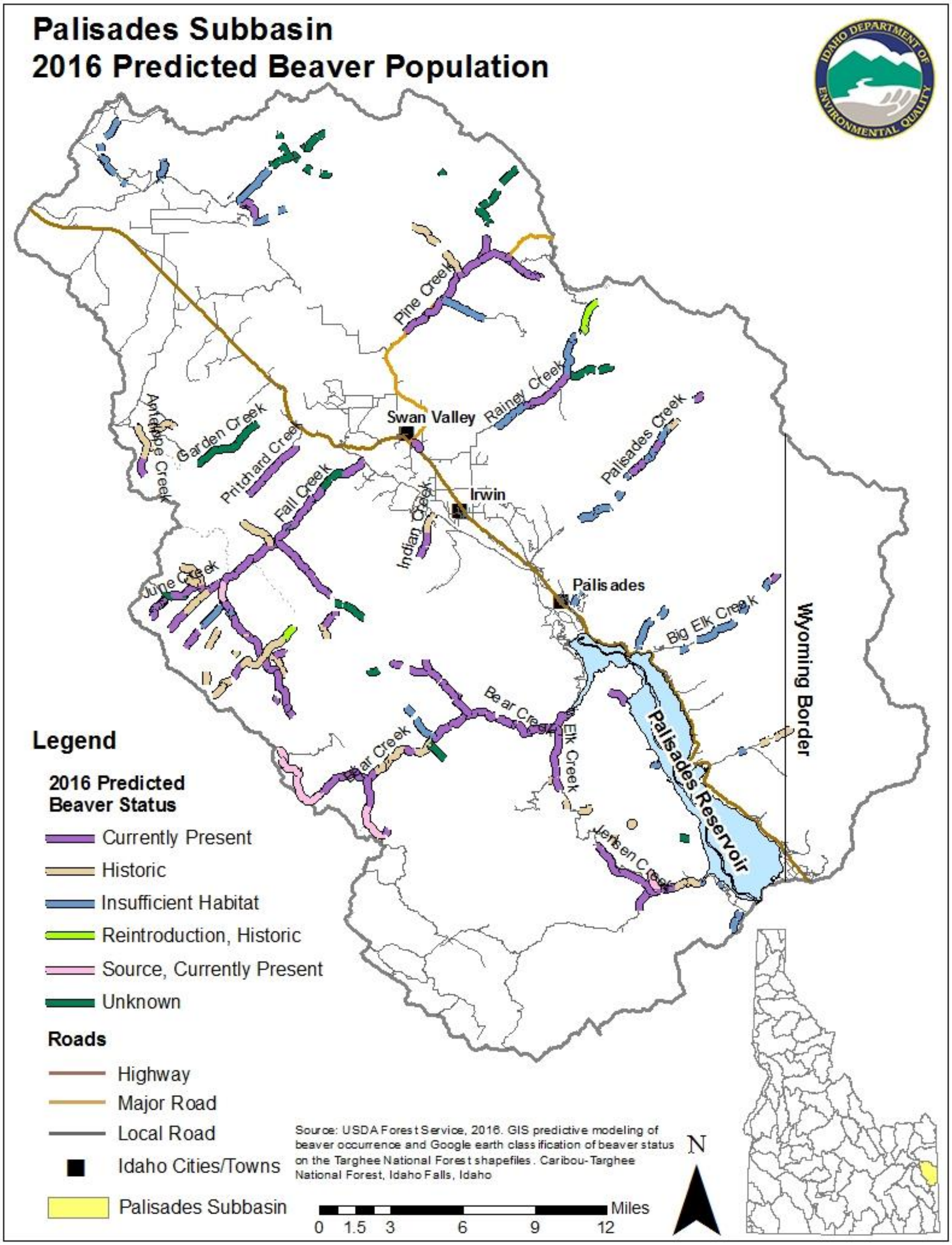

Figure 4. Palisades subbasin—2016 predicted beaver population (USFS 2012).

Table 7. 2017 streambank erosion inventory results.

Water Body and Assessment Unit	Current Load (Tons/Year)	Load Capacity (Tons/Year)	% Erosion Reduction Required	% Streambank Stability (2017 SEIs)	% Streambank Stability (Previous SEIs/TMDLs)
Snake River (Upper) ID17040104SK001_02	1.9	9.9	0	93	83
Snake River (Lower) ID17040104SK001_02	0.2	2.6	0	98	76
Antelope Creek ID17040104SK002_02	2.3	4.4	0	89	81
Fall Creek (Gibson Creek) ID17040104SK006_02	2.0	3.1	0	87	26
Fall Creek (Gibson Creek) ID17040104SK006_03	7.0	10.8	0	87	88
Fall Creek (Lower) ID17040104SK006_04	4.1	12.9	0	94	94
Fall Creek II (Upper) ID17040104SK006_04	17.6	20.1	0	83	94
Snake River (Indian Creek) ID17040104SK008_02	4.4	5.9	0	85	92
Snake River (Sheep Creek) ID17040104SK008_02	12.5	16.1	0	85	100
Bear Creek ID17040104SK011_04	1.6	9.1	0	97	68
Bear Creek ID17040104SK013_02	0.8	9.4	0	98	68
Bear Creek ID17040104SK013_03	53.8	110.7	0	90	68
Indian Creek ID17040104SK024_04	68.7	86	0	84	68
Rainey Creek (Upper) ID17040104SK028_04	0.3	6.8	0	99	—
Rainey Creek (Lower) ID17040104SK028_04	5.4	27.7	0	96	—

2.3.3 Temperature Data

Temperature loggers were deployed within the Rainey Creek and Fall Creek AUs to evaluate if the AUs met temperature criteria for their beneficial uses (cold water aquatic life and salmonid spawning).

Temperature loggers were deployed in the upper, mid, and lower portions of Rainey Creek from July 2017 to November 2017. Data retrieved from the loggers confirmed that the upper, mid, and lower portions of the AU were not temperature impaired for the cold water aquatic life beneficial use; however, these areas were temperature impaired for the salmonid spawning beneficial use, with temperatures exceeding the daily average and daily maximum criteria.

Temperature loggers were deployed in three Fall Creek AUs—June Creek (ID17040104SK006_02), Gibson Creek (ID17040104SK006_03), and Fall Creek (ID17040104SK006_04)—from August 2017 to November 2017. Data retrieved from the loggers showed the AUs were not temperature impaired for the cold water aquatic life beneficial use but were for salmonid spawning. Daily average and daily maximum salmonid spawning temperatures were exceeded on all Fall Creek AUs.

Table 8 summarizes the temperature exceedances. As expected, sites in the upper AUs at higher elevations did not experience as many temperature exceedances. Appendix C contains the temperature logger data, location coordinates for each site, and graphs that summarize the high, low, average, and diurnal daily temperatures of each site throughout the deployment period.

Table 8. Days (number and percentage) exceeding water quality criteria for temperature.

Location and Assessment Unit	Days Exceeded—COLD Daily Average (19°C)	Days Exceeded—COLD Daily Maximum (22 C)	Days Exceeded—SS Daily Average (9°C)		Days Exceeded—SS Daily Maximum (13°C)	
June Creek FC2 ID17040104SK006_02	0	0	38/95	40%	28/95	29%
Gibson Creek FC3 ID17040104SK006_03	0	0	37/95	39%	36/95	38%
Fall Creek FC1 ID17040104SK006_04	0	0	43/95	45%	37/95	39%
Rainey Creek RC1 (Lower AU) ID17040104SK028_04	0	0	76/118	64%	59/118	50%
Rainey Creek RC2 (Mid AU) ID17040104SK028_04	0	0	46/118	39%	15/118	13%
Rainey Creek RC4 (Upper AU) ID17040104SK028_04	0	0	10/118	8%	0	0%

Notes: cold water aquatic life (COLD), salmonid spawning (SS). Fractions represent number of sampling days with exceedances out of the total number of sampling days.

For this review, temperature logger data were collected beginning in July (Rainey Creek) and August (Fall Creek) and ending in November. Because the critical period for cold water aquatic life is July 15–August 15 and the critical period for salmonid spawning varies, the temperature loggers listed in Appendix C will remain in the streams to capture 2018 spring and summer temperatures for analyses in a future 5-year review cycle.

2.3.4 Potential Natural Vegetation Data

The PNV approach was applied to 4 AUs in the Palisades subbasin during the 2017 field season. Solar Pathfinders were used along representative reaches of 3 of the AUs to record shade measurements provided by existing riparian communities along the streambanks. To determine if a shade deficit exists, these shade measurements were compared to shade targets of the same fully established riparian communities. The difference between existing shade and potential shade typically results in the need for a temperature load reduction, which was the case with Rainey Creek (ID17040104SK028_04). However, PNV results from the Fall Creek AUs (ID17040104SK006_02, ID17040104SK006_03, and ID17040104SK006_04) indicated sufficient vegetation exists along the streambanks to provide adequate shade to the streams.

The *Fall Creek Watershed Assessment and Total Maximum Daily Load* (DEQ 2003) prepared for the Fall Creek AUs (ID17040104SK006_02, ID17040104SK006_03, and ID17040104SK006_04) mentions that hydrothermal waters and mineral springs are common to Fall (ID17040104SK006_04) and Camp Creeks (ID17040104SK006_02) and that travertine, a hard mineral resistant to erosion, is formed in the Fall Creek watershed when hydrothermal waters and mineral springs evaporate. Because the TMDL did not provide details on these sources, additional monitoring should be conducted on the Fall Creek AUs to determine the causes and locations of these sources.

Idaho water quality standards (IDAPA 58.01.02.200.09) state there is no impairment of beneficial uses or violations of water quality standards where natural background conditions exceed any applicable water quality criteria. The PNV approach assumes that stream temperatures are at natural background temperatures when stream shade and channel widths are at natural levels and other anthropogenic sources of heat, such as point source discharges, are absent. Although temperature logger data from the Fall Creek AUs exceeded SS numeric water quality criteria, the PNV approach indicated that sufficient riparian habitat exists along the streambanks to meet shade targets. See section 5 for details on the PNV approach.

2.3.5 *E. coli* Bacteria Sampling Data

In 2014, a bacteria TMDL (DEQ 2015a) for Rainey Creek (ID17040104SK028_04) was approved using 1999 sample data that resulted in a geometric mean of 200 colony forming units per 100 milliliters (cfu/100 mL). Idaho water quality standards state that *E. coli* bacteria are not to exceed 126 cfu/100 mL as a five-sample, 30-day geometric mean. Single sample thresholds that trigger additional monitoring are 406 cfu/100 mL for primary contact recreation and 576 cfu/100 mL for secondary contact recreation. If a single sample maximum is exceeded, four additional samples must be taken every 3 to 7 days within a 30-day period to determine the geometric mean concentration and compare it to the standard (IDAPA 58.01.02.251.01–02).

As part of the 5-year review and ongoing monitoring for existing TMDLs, five samples at Rainey Creek were taken to calculate a geometric mean (Table 9). The samples were taken at the same location each time, near where the 1999 samples were taken (DEQ 2015a). The geometric mean of the 2017 samples was 107 cfu/100 mL, which was less than the standard of 126 cfu/100 mL. Each sample was well below the single sample value of 576 cfu/100 mL for secondary contact recreation, except the sample taken on September 21, 2017, that was likely due to a storm-related event.

The weeks leading up to the September 21 sample were mostly dry, which likely allowed bacteria levels to accumulate on the ground. National Oceanic and Atmospheric Administration data confirmed that from September 1 through September 13, 2017, no precipitation occurred pursuant to weather station #108937 in Swan Valley, Idaho. September 14-17 experienced minor precipitation and it was dry September 18. However, 0.23 inches fell on September 19, 2017, and 0.87 inches fell on September 21, 2017 (Appendix C, Figure C1). The accumulated bacteria was transported to the stream via overland flow the day before and the day of the sampling event, triggering a single sample exceedance. Although an exceedance of single sample criteria does not indicate a violation of water quality standards, additional samples will be taken in 2018 to ensure compliance is met.

Table 9. Rainey Creek *E. coli* sampling results.

Date	*E. coli* cfu/100 mL	Sampling Location
08/28/17	70.3	43.447320, -111.331450
08/31/17	69.7	
09/07/17	85.7	
09/14/17	58.3	
09/21/17	579.4	
Geometric Mean	**107.2**	

Note: colony forming units per 100 milliliter (cfu/100 mL)

2.3.6 Status of Beneficial Uses

Since 2004, the Palisades subbasin has seen an increasing population trend of Yellowstone Cutthroat Trout in two locations on the South Fork Snake River. In 2013, trout abundances in the South Fork Snake River were near an all-time high (IDFG 2015). BURP data collected in the Palisades subbasin in 2017 corroborate the IDFG monitoring and suggest that beneficial use support is improving. All SEIs conducted on Category 4a and 5 AUs indicated that streambank stability was greater than 80%. The bacteria monitoring on Rainey Creek (ID17040104SK028_04) showed that the AU met the geometric mean criteria. Of the 4 AUs where temperature loggers were deployed and the PNV approach was applied, only one (Rainey Creek) was shade deficient, and a TMDL was developed with this document (see section 5). Although the data have shown improvements, additional investigations are required to determine if the beneficial uses of the streams in the Palisades subbasin are fully supported.

2.3.7 Assessment Unit Summary

A summary of the data analysis, literature review, and field investigations and a list of conclusions for AUs included in Category 5 of the 2014 Integrated Report (DEQ 2016a) follows. This section includes changes that will be documented in the next Integrated Report once EPA has approved the TMDLs in this document.

2.3.7.1 Category 5 Assessment Unit Summary

ID17040104SK008_02, Snake River—Palisades Reservoir Dam to Fall Creek

- Listed for combined biota/habitat bioassessments and sedimentation/siltation.
- This unit contains 1st- and 2nd-order tributary streams to Fall Creek and includes Deer, Dry Gulch, Indian, Little Sheep, Papoose, Russell, Sawmill Canyon, Sheep, Squaw, Tag Alder, and Yeaman Creeks.
- SEIs were conducted on Indian and Sheep Creeks. SEI results indicated that streambank stability for both creeks was above 80%. SEIs performed in previous years in the AU had similar results.
- Remove sedimentation/siltation as a cause of impairment from Category 5. Results from SEIs performed for this TMDL and the previous TMDL (DEQ 2015a) indicated the streams in this AU are meeting sediment targets.
- Keep in Category 5 as impaired for combined biota/habitat bioassessments until the ultimate cause of impairment is determined.

ID17040104SK028_04, Rainey Creek—source to mouth

- Listed for combined biota/habitat bioassessments.
- This unit contains a 4th-order tributary stream, including Rainey Creek and one unnamed creek, to the South Fork Snake River.
- Two SEIs were conducted on this AU: one at the upper portion and one at the mid portion. SEI data indicated that streambank stability for both locations was above 80%.
- Three temperature loggers were deployed in Rainey Creek at the upper, mid, and lower AU from July to November 2017. Data showed that the cold water aquatic life beneficial use is not impacted by temperature; however, temperatures for the salmonid spawning beneficial use in the lower portion of the AU were exceeded 76 of 118 days. Exceedances of the mid and upper portions of the AU also occurred but were less frequent, with 46 days at the mid portion and 10 at the upper.
- The PNV approach showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. This AU received a new PNV temperature TMDL with this review (see section 5).
- No other pollutant sources were found, and temperature replaces combined biota/habitat bioassessments as the listing impairment.
- Move from Category 5 for combined biota/habitat bioassessments to Category 4a for a temperature TMDL.

ID17040104SK029_03, Pine Creek—source to mouth

- Listed for cause unknown.
- This AU contains 3rd-order tributary streams, including North Fork Pine Creek and Pine Creek to the Palisades Reservoir.
- This AU was not evaluated since further investigation is necessary to determine a potential cause.
- Keep in Category 5 for cause unknown until a potential cause is determined.

3 Pollutant Source Inventory

Pollution within the Palisades subbasin is primarily from sediment, bacteria, and temperature. Load allocations for sediment, bacteria, and temperature were established and approved by the EPA with the following TMDLs:

- *Palisades Subbasin Assessment and Total Maximum Daily Load Allocations* (sediment) (DEQ 2001),
- *Fall Creek Watershed Assessment and Total Maximum Daily Load* (sediment and temperature) (DEQ 2003),
- *Palisades Subbasin Total Maximum Daily Loads 2013 Addendum and Five-Year Review* (sediment and bacteria) (DEQ 2015a).

3.1 Point Sources

There are no known point sources within the Palisades Subbasin. Therefore no wasteload allocations will be developed for any of the §303(d) listed or TMDL water bodies. There is no municipal separate storm sewer (MS4) conveyance system required within the Palisades subbasin due to the low population. There are also no industrial facilities within the Palisades subbasin that discharge into waters. Therefore, no coverage is required under the Multi-Sector General Permit (MSGP).

During research for this document, only one Construction General Permit (CGP) was discovered in the EPA's database. Although the database mentioned that construction activities were covered under the CGP, the applicant applied for and received coverage under the Existing Low Erosivity Waiver (LEW) for Exclusion from Stormwater Permitting. In September 2018, LEW coverage was terminated by the applicant. No discharges to affected water bodies were known to occur.

3.2 Nonpoint Sources

Previous analyses indicate that the primary source of excess sediment in the Palisades subbasin is streambank erosion. Other potential sources of sediment pollution in any watershed can include roads built too close to streams, deferred road maintenance due to lack of funding, return water from ditches laden with sediment to natural waters, erosion from cultivated fields, mass wasting or landslides related to improper engineering techniques, and urban stormwater runoff. Streambank erosion is a significantly greater long-term source of pollution than these other potential sources.

Sediment from streambank erosion is delivered directly to the stream channel without attenuation or deposition, as is often the case with natural hillslope erosion. Depositional features that result from streambank erosion often further accelerate erosion by redirecting flow into formerly stable streambanks. Eventually, streambank stability is reduced. As streambanks erode and streams widen, riparian vegetation and shade decreases, which further decreases streambank stability and increases the thermal load to the stream. Excess heat is another pollutant related to streambank stability.

Because the temperature TMDL in section 5 is based on PNV-style riparian shade calculations, which are equivalent to natural background loading, the load allocation is essentially the desire to achieve shade that would be present without human disturbance. However, to reach that objective, load allocations are assigned to nonpoint source activities that have affected or may affect riparian vegetation and shade as a whole. Therefore, load allocations are stream segment specific and dependent on the target load for a given segment. This target load (i.e., load capacity) is necessary to achieve natural background conditions. No opportunity exists to further remove shade from the stream by any activity without exceeding its load capacity. Additionally, because this TMDL is dependent on natural background conditions for achieving water quality standards, all tributaries to the waters examined here need to reflect natural conditions to prevent excess heat loads to the stream.

Certain land uses and wildlife activity are closely correlated to nonpoint bacteria sources. Bacteria containing solids are deposited on land surfaces from various sources. During rainfall events, overland flows transport these bacteria-containing matter to surface waters. The ability for bacteria to survive in water is dependent on a number of variables such as temperature, soil moisture, nutrients present in the water, and pH. Concentrations of bacteria can be affected by many variables as well, including die-off, regrowth, the amount of and distance from the contamination source to surface waters, and sediment disturbance, which can increase bacteria concentrations.

3.3 Pollutant Transport

Pollutant transport refers to the pathway by which pollutants move from the pollutant source to cause a problem or water quality violation in the receiving water body.

In the case of sediment, transport is a function of particle size and characteristics of the stream channel, such as morphological type, gradient, and width/depth ratio. Smaller particles transport farther in the channel before coming to rest in depositional areas of the stream. Channel characteristics determine the velocity of streamflow. Higher velocities cause higher scouring and deposition of particles farther downstream than would occur naturally.

Most temperature pollutant transport is in the form of solar radiation directly to the stream as a result of exposure. Temperature problems result from solar radiation due to a loss of streamside vegetation.

Bacteria pollutant transport is facilitated by wet weather runoff, erosion, seepage, and direct impacts to the stream. Typical sources of bacteria pollution include failing septic systems; decaying matter; agriculture; and pet, livestock, and wildlife waste.

4 Summary of Past and Present Pollution Control Efforts and Monitoring

4.1 5-Year Review of TMDLs

To comply with Idaho Code §39-3611(7), this TMDL addendum and 5-year review reevaluates the *Palisades Subbasin Total Maximum Daily Loads: 2013 Addendum and Five-Year Review* (DEQ 2015a). This review describes current water quality status and the monitoring that DEQ completed during the 2017 field season. Below is a summary of the AUs evaluated for the 5-year review.

ID17040104SK001_02, Snake River—Black Canyon Creek to river mile 856

- Listed for sedimentation/siltation in Category 4a (approved TMDL) in the 2014 Integrated Report.
- This AU contains 1st- and 2nd-order tributary streams to the South Fork Snake River, including Spring Creek, Woods Creek, Wolverine Creek, Mud Creek, and 29 unnamed streams.
- Two SEIs (upper and lower portions of the AU) were conducted on one of the unnamed tributaries in Table Rock Canyon. The lower portion of the stream was dry and likely intermittent. SEI data indicated that streambank stability for both locations was greater than 80%.

- Keep in Category 4a for sedimentation/siltation until further investigations show full support of beneficial uses. Future BURP monitoring on this AU will provide beneficial use support determinations. Supplemental sediment and macroinvertebrate surveys may also help support a future delisting.

ID17040104SK002_02, Antelope Creek—source to mouth

- Listed for sedimentation/siltation in Category 4a (approved TMDL) in the 2014 Integrated Report.
- This AU contains 1st- and 2nd-order tributary streams to the South Fork Snake River, including Antelope Creek, Little Pine Creek, Trail Creek, and 33 unnamed streams.
- One SEI was conducted on Antelope Creek, which indicated that streambank stability was above 80%. Finding a sufficient length on the AU to conduct the SEI without encountering a beaver dam was a challenge.
- Keep in Category 4a for sedimentation/siltation until further investigations show full support of beneficial uses. Future BURP monitoring on this AU will provide beneficial use support determinations. Supplemental sediment and macroinvertebrate surveys may also help support a delisting in the future.

ID17040104SK002_03, Antelope Creek—source to mouth

- Listed for sedimentation/siltation in Category 4a (approved TMDL) in the 2014 Integrated Report.
- This AU contains 3rd-order tributary streams to the South Fork Snake River, including Antelope Creek and two unnamed streams.
- This AU was not evaluated due to its inaccessibility and location on private property.
- Keep in Category 4a for sedimentation/siltation until the AU is evaluated.

ID17040104SK006_02, Fall Creek—source to South Fork Fall Creek

- Listed for sedimentation/siltation and temperature in Category 4a (approved TMDL) in the 2014 Integrated Report.
- This AU contains 1st- and 2nd-order tributary streams to the South Fork Snake River, including Bates Creek, Beaver Creek, Camp Creek, East Fork Fall Creek, Fall Creek, Gibson Creek, Haskin Creek, June Creek, Monument Creek, Porcupine Creek, Sawmill Creek, Trap Creek, Willow Springs Creek, and 32 unnamed streams.
- One SEI was conducted on Gibson Creek, which indicated that streambank stability was above 80%.
- A temperature logger deployed in June Creek from August to November 2017 showed that the cold water aquatic life beneficial use was not impacted by temperature. However, temperatures for the salmonid spawning beneficial use were exceeded on 38 of 95 days. The temperature exceedances in this AU are most likely due to hydrothermal springs that are tributaries to the lower reaches of Fall Creek (DEQ 2003). Hydrothermal seeps and springs may also contribute to increased conductivity in the surface water (USFS TNF 1999, 2000).
- Shade monitoring was conducted on this AU. The PNV approach showed adequate shade from existing riparian vegetation when compared to shade targets for similar vegetation types and stream widths (see section 5). No revised temperature TMDL was required.

- Keep in Category 4a for sedimentation/siltation and temperature until further investigations show full support of beneficial uses. Future BURP monitoring on this AU will provide beneficial use support determinations. Supplemental sediment and macroinvertebrate surveys may also help support a future delisting.

ID17040104SK006_03, Fall Creek—source to South Fork Fall Creek

- Listed for sedimentation/siltation and temperature in Category 4a (approved TMDL) in the 2014 Integrated Report.
- This AU contains 3rd-order tributary streams to South Fork Fall Creek, including East Fork Fall Creek, Fall Creek, and Gibson Creek.
- One SEI was conducted on Gibson Creek, which indicated that streambank stability was above 80%. Numerous beaver dams existed along this AU, and SEI locations were changed in the field as a result.
- A temperature logger deployed in Gibson Creek from August to November 2017 showed that the cold water aquatic life beneficial use was not impacted by temperature. However, temperatures for the salmonid spawning beneficial use were exceeded on 37 of 95 days. The temperature exceedances in this AU are most likely due to hydrothermal springs that are tributaries to the lower reaches of Fall Creek (DEQ 2003). Hydrothermal seeps and springs may also contribute to increased conductivity in the surface water (USFS TNF 1999, 2000).
- Shade monitoring was conducted on this AU. The PNV approach showed adequate shade from existing riparian vegetation when compared to shade targets for similar vegetation types and stream widths (see section 5). No revised temperature TMDL was required.
- Keep in Category 4a for sedimentation/siltation and temperature until further investigations show full support of beneficial uses. Future BURP monitoring on this AU will provide beneficial use support determinations. Supplemental sediment and macroinvertebrate surveys may also help support a future delisting.

ID17040104SK006_04, Fall Creek—source to South Fork Fall Creek

- Listed for sedimentation/siltation and temperature in Category 4a (approved TMDL) in the 2014 Integrated Report.
- This AU contains Fall Creek, a 4th-order tributary stream to South Fork Fall Creek.
- Two SEIs conducted on this AU indicated that streambank stability was above 80%. One of the SEIs ended at a beaver dam and the other was moved in the field due to the abundance of beaver dams along the AU.
- A temperature logger deployed in Fall Creek from August to November 2017 showed that the cold water aquatic life beneficial use was not impacted by temperature. However, temperatures for the salmonid spawning beneficial use were exceeded on 43 of 95 days. The temperature exceedances in this AU are most likely due to hydrothermal springs that are tributaries to the lower reaches of Fall Creek (DEQ 2003). Hydrothermal seeps and springs may also contribute to increased conductivity in the surface water (USFS TNF 1999, 2000).
- Shade monitoring was conducted on this AU. The PNV approach showed adequate shade from existing riparian vegetation when compared to shade targets for similar vegetation types and stream widths (see section 5). No revised temperature TMDL was required.

- Keep in Category 4a for sedimentation/siltation and temperature until further investigations show full support of beneficial uses. Future BURP monitoring on this AU will provide beneficial use support determinations. Supplemental sediment and macroinvertebrate surveys may also help support a future delisting.

ID17040104SK011_04, Bear Creek—North Fork Bear Creek to Palisades Reservoir

- Listed for sedimentation/siltation in Category 4a (approved TMDL) in the 2014 Integrated Report.
- This AU contains a 4th-order tributary stream to the Palisades Reservoir.
- One SEI conducted on Bear Creek indicated that streambank stability was above 80%. However, BURP results from 2015 indicated that beneficial uses were not being supported.
- Keep in Category 4a for sedimentation/siltation until further investigations show full support of beneficial uses. Future BURP monitoring on this AU will provide beneficial use support determinations. Supplemental sediment and macroinvertebrate surveys may also help support a future delisting.

ID17040104SK013_02, Bear Creek—source to North Fork Bear Creek

- Listed for sedimentation/siltation in Category 4a (approved TMDL) in the 2014 Integrated Report.
- This AU contains 1st- and 2nd-order tributaries to North Fork Bear Creek, including Deadman Creek, Bear Creek, Warm Springs Creek, South Fork Bear Creek, Chaparral Creek, and 28 unnamed streams.
- One SEI conducted on this AU indicated that streambank stability was above 80%. The original location for the SEI contained numerous beaver dams, and an alternate location was dry. Even the alternate location appeared to once have contained numerous beaver dams, as the creek was very wide with many braids, indicative of beaver activity.
- Keep in Category 4a for sedimentation/siltation until further investigations show full support of beneficial uses. Future BURP monitoring on this AU will provide beneficial use support determinations. Supplemental sediment and macroinvertebrate surveys may also help support a future delisting.

ID17040104SK013_03, Bear Creek—source to North Fork Bear Creek

- Listed for sedimentation/siltation in Category 4a (approved TMDL) in the 2014 Integrated Report.
- This AU contains a 3rd-order tributary to North Fork Bear Creek.
- One SEI conducted on this AU indicated that streambank stability was above 80%. This AU contained a number of beaver dams along the reach. The SEI ended at a beaver dam.
- Keep in Category 4a for sedimentation/siltation until further investigations show full support of beneficial uses. Future BURP monitoring on this AU will provide beneficial use support determinations. Supplemental sediment and macroinvertebrate surveys may also help support a future delisting.

ID17040104SK024_04, Indian Creek—Idaho/Wyoming border to Palisades Reservoir

- Listed for sedimentation/siltation in Category 4a (approved TMDL) in the 2014 Integrated Report.

- This AU contains a 4th-order tributary to the Palisades Reservoir.
- One SEI conducted on this AU indicated that streambank stability was above 80%. Previous SEIs produced the same results. BURP results from 2015 indicated that beneficial uses were not being supported.
- Keep in Category 4a for sedimentation/siltation until further investigations show full support of beneficial uses. Future BURP monitoring on this AU will provide beneficial use support determinations. Supplemental sediment and macroinvertebrate surveys may also help support a future delisting.

ID17040104SK028_04, Rainey Creek—source to mouth

- Listed for *E. coli* in Category 4a (approved TMDL) in the 2014 Integrated Report.
- This AU contains 4th-order tributary streams to the South Fork Snake River, including Rainey Creek and one unnamed creek.
- Bacteria sampling during August and September 2017 did not exceed the geometric mean of 126 cfu/100 mL; however, one of the samples did exceed the single sample trigger value.
- Keep in Category 4a for *E. coli* until additional bacteria sampling confirm whether an impairment exists.

4.2 Palisades Subbasin Restoration Projects (2011–2017)

Since completion of the *Palisades Subbasin Total Maximum Daily Loads: Addendum and Five-Year Review* (DEQ 2015a), regular monitoring of the stream water and habitat quality by DEQ has occurred in the Palisades subbasin. In addition, numerous research and restoration activities noted below have been completed or are currently being implemented by local, state, private, and federal agencies. Further details and information regarding these activities can be acquired from the managing agency or responsible group.

4.2.1 Trout Unlimited and USFS Project

The Rainey Creek Stream and Riparian Restoration (2017) — TU and the USFS partnered on this project within the Rainey Creek drainage near Swan Valley, Idaho. It addressed approximately 13 eroding streambank sites, representing approximately 1,300 feet of streambank. Most of the sites had previously undergone juniper revetment streambank stabilization treatments. However, these treatments did not provide sufficient protection for streambank stabilization likely due to many of the locations having high streambanks that lack riparian wood vegetation necessary to provide root strength and promote streambank stability.

Eroding streambank locations were mechanically reshaped and junipers were trenched in to create additional streambank protection to mimic naturally occurring log jam complexes found in Rainey Creek. Whole willow transplants and willow cuttings were also incorporated to promote root development at the streambank edge and develop long-term streambank stability to reduce streambank erosion and increase water quality, stream stability, and fish habitat complexity.

Cottonwoods were re-established by planting approximately 200 cottonwood seedlings in select locations along the north and south sides of the Rainey Creek riparian area (170 acres). Historically, cottonwood regeneration along the Rainey Creek riparian corridor had been heavily impacted by grazing, dispersed camping, and big game overwintering. Cottonwood seedlings were planted at the same time the streambank stabilization occurred, which limited the amount of ground-disturbing activities.

Before and after restoration conditions are shown in Figure 5 and Figure 6.

Figure 5. Before restoration activities. Source: USFS.

Figure 6. After restoration activities. Source: USFS.

4.2.2 United States Forest Service Projects—Caribou-Targhee National Forest

West Pine Creek Trail Bridge (2017)—A nonmotorized eroding trail ford crossing was replaced with a trail bridge.

Vannoy Farm Rehabilitation (2011–Current)—The Palisades Ranger District is reclaiming and converting farmland to native vegetation on 108 acres south of Swan Valley near Indian Creek (ID17040104SK008_02) (Figure 7). This work involves seeding or planting native rooted plants on about 15 acres and treating noxious weeds annually.

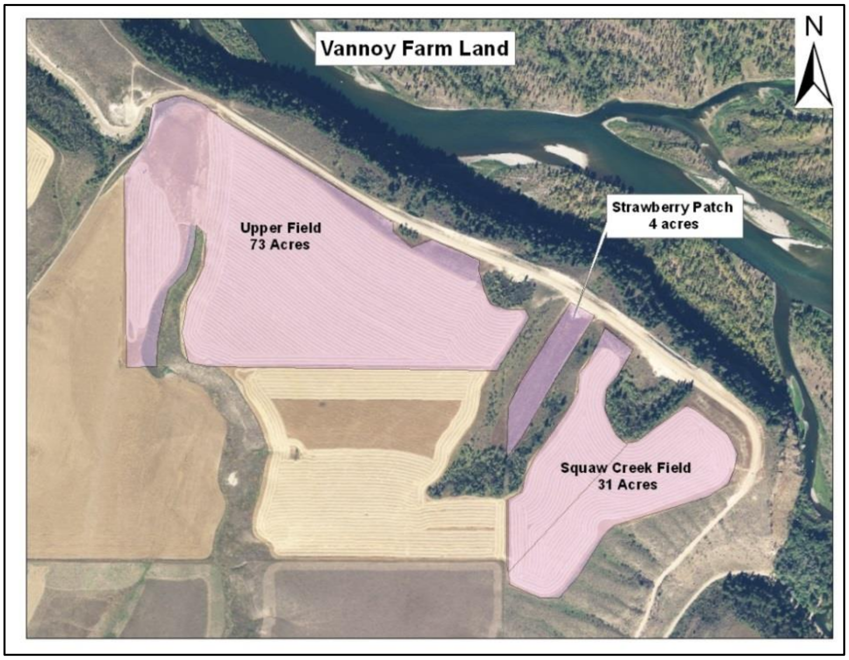

Figure 7. Aerial view of the Vannoy Farm. Source: USFS.

Pine Basin Bridge Replacement (2016)—The Pine Basin Bridge is located on the access road to the Bonneville School District's Pine Basin Camp. The road and bridge are owned by the USFS and provide access to the camp and Bonneville Power Administration (BPA) right-of-way. Bridge deterioration had restricted loaded buses from driving into the camp and a hole, formed in the concrete deck, was becoming a public safety concern. The project replaced the existing 36-foot long bridge with a 45-foot long bridge providing a clear opening of 43 feet between abutments, meeting the 40-foot bankfull width requirement and allowing for hydrological function recovery and reduced streambank erosion.

Tie Canyon Trail Burn Area Emergency Rehabilitation (**BAER**) **Work (2016)—**Three bog bridges and two trails were stabilized.

Trail 077 Pine Creek Pass/Trail Reroute (2016)—0.25 miles of trail was rerouted to eliminate a perennial stream crossing.

Calamity Campground Trail Obliteration (2016)—0.8 miles of nonsystem road/ATV trail, including two stream crossings, was obliterated.

Heavy Trail Reconstruction/Maintenance (2016)—4.01 miles of trails received heavy maintenance, including building new water bars, routing trails out of the drainage bottom, closing areas of braided trails to limit the trail to a single well-built trail, and restoring abandoned trail sections. Trails included Lookout Mountain (0.93 miles), Wolverine/Hawley (0.42 miles), Morning Glory Mine (2.04 miles), Windy Ridge Connector (0.43 miles), and Fish Creek (0.28 miles).

Fall Creek ATV Trail Bridge (2015)—An eroding ATV ford was replaced with a bridge on Fall Creek at Willow Springs Creek.

South Fork Fall Creek ATV Trail Improvements (2015)—3.5 miles of heavy trail reconstruction occurred on South Fork Fall Creek and included repair work at problem spring crossings and wet areas. Two new culverts were installed, and the trail was reshaped to drain in several locations.

West Pine Creek Stream Restoration (2015)—This project addressed a public safety issue and provided essential habitat for the native Yellowstone Cutthroat Trout, an identified sensitive species. The old undersized Highway 31 Bridge that contained a 14-foot wide stream opening was replaced with a 20-foot wide span to restore hydrologic function and stability at the crossing on West Pine Creek.

The associated stream restoration work on West Pine Creek meandered the straightened, ditch-like channel, increasing the length from approximately 907 feet to 1,143 feet and restoring an additional 236 feet of channel and associated aquatic habitat. The increase in channel length decreased stream slope and stream flow, which created additional slow water pool habitat for aquatic organisms. The restored channel reconnected the stream to its floodplain by elevating the stream nearly 4 to 6 feet at the lower end, which will eventually create an additional 17,450 square feet (0.4 acres) of wetlands along the restored stream corridor at a minimum. The project also restored up to 5 acres of riparian habitat by converting adjacent sage brush areas into willow- and cottonwood-dominated valley bottom. Figure 8–Figure 11 depict before and after restoration conditions.

Figure 8. Looking down the valley along Forest Service Road 230 (on the right) at the downcut 3 to 5-foot West Pine Creek. The channel is disconnected from the floodplain and contains limited riparian and wetland habitat (before). Source: USFS.

Figure 9. The stream is now reconnected to the floodplain allowing restoration of the riparian habitat (after). Source: USFS.

Figure 10. Old Highway 31 Bridge crossing at West Pine Creek (before). Source: USFS.

Figure 11. Newly reconstructed bridge. Whole willows were transplanted and whole tree revetment restoration design treatments provided vegetation recovery, stream stability, and instream aquatic habitat (after). Source: USFS.

Heavy Trail Reconstruction/Maintenance (2014)—The Palisades Ranger District partnered with Idaho Department of Parks and Recreation to complete trail maintenance on 16.2 miles of trail. The trail cat preformed heavy maintenance on the trails, improving watershed conditions by cleaning out and installing water bars where needed, improving the tread, closing alternate/user created routes, and making the trail passable by the vehicles for which it was designated. All of the trails maintained were designated for use by motor vehicles 50 inches wide or less and nonmotorized traffic. The following trails were maintained: Thousand Springs (3.2 miles), Rash Canyon (3.8 miles), South Fork/Rash (2.4 miles), 4th of July Ridge (4.3 miles), and Bear Creek (2.5 miles).

Red Creek Trail (#241) Reroute (2014)—A 50-foot section of the Red Creek Trail (#241) was rerouted to remedy seasonal events where the stream flowed along the trail. Before and after restoration conditions are shown in Figure 12 and Figure 13.

Figure 12. The stream inundated Red Creek Trail during spring runoff (before). Source: USFS.

Figure 13. The trail was removed from the aquatic influence zone and the area restored (after). Source: USFS.

Tie Canyon Road Repair and Trailhead Relocation (2013)—The project relocated the trailhead out of the riparian area, stabilized streambanks, and enhanced and protected water quality and Yellowstone Cutthroat Trout habitat. The lower section of the Tie Canyon Trail (#200) was relocated further from the stream channel and connected to the new trailhead. The old trail was reclaimed. The project improved road conditions and reduced erosion by placing road material (pit run) and finish layer (3/4 minus) on Forest Service Road 252 and the trailhead. Figure 14 and Figure 15 show before and after restoration conditions.

Figure 14. The trail runs through the riparian area (before). Source: USFS.

Figure 15. The trail was rerouted and riparian area restored (after). Source: USFS.

Mike Spencer Road Emergency Floodplain Drainage Project (2013)—This was an emergency watershed protection funded project. Improvements were made to the floodplain drainage on the Mike Spencer Road crossing of Pine Creek.

Indian Creek Bridge and North Indian Creek Trail Stabilization (2012)—This project stabilized the North Indian Creek bridge abutments on Forest Service Road 281 and a streambank slightly upstream from the bridge. In association with this project, a portion of the North Indian Creek motorized trail was converted from a double track trail to a single track trail.

Palisades Sheep Driveway Seeding (2011)—The Palisades Sheep Driveway is used by several bands of sheep to access allotments and return to the corrals for shipping at the end of the grazing season. Historically, several bands of sheep used the driveway each season, which led to vegetation removal and erosion in some areas. Over the years, the number of permitted sheep has been reduced, allotments have been designed to reduce trailing, and sheep men are trucking sheep instead of trailing them across the driveway. A native seed mix was used to seed approximately 8 acres of the Sheep Driveway to increase ground cover and reduce erosion.

Upper Rainey Creek Trail and Road Rehabilitation (2011)—Road work focused on stabilizing a slump area and graveling the lower section (approximately 2 miles). The stream stabilization portion of the project used natural streambank protection techniques to stabilize a 600-foot section of the streambank. The trail work improved and relocated a section of the Hunts Corral Trail that fell within the riparian area and improved a wetland crossing through the construction of timbered bog bridges.

North Fork Bear and Elk Creek Road and Trail Improvements (2011)—North Fork Bear Trail is a 5.8-mile trail that falls within the riparian area and crosses the stream and wet areas several times. The project improved and relocated over 30% of the trail (5 acres) and upgraded an undersized culvert on the Pine Creek/Elk Jensen Forest Service Road 058 to prevent high flow road capture or failure.

4.2.3 Idaho Department of Fish and Game

Burns and Pine Creeks Passive Integrated Transponder (PIT) Tag Antenna Systems (2011 and 2012)—Two PIT tag antenna systems were installed in the Palisades subbasin to detect directionality of Yellowstone Cutthroat Trout movement (upstream or downstream). The objective of these systems is to better understand Yellowstone Cutthroat Trout movement so appropriate management decisions can be made to ensure their long-term viability in the South Fork Snake River system. Each antenna is approximately 2 feet wide and 20 feet long and is imbedded in the streambed so that the top of the antennas are flush with the streambed allowing gravel and other debris to pass over them. The antennas are attached to a receiver that decodes signals picked up from PIT tags as fish marked with these tags swim over the antennas. These fixed arrays are powered by thermoelectric generators and run on propane. IDFG operates the arrays from April through December. In Burns Creek, two antennas were placed 30 feet apart; in Pine Creek, four antennas were imbedded into the streambed: two across the channel and two more 30 feet downstream. Figure 16 and Figure 17 show the PIT tag antenna system that was installed adjacent to and in Burns Creek.

Figure 16. Burns Creek PIT tag antenna receiver. Source: USFS.

Figure 17. Burns Creek PIT tag antenna. Source: USFS.

4.2.4 United States Bureau of Land Management

The BLM receives Land and Water Conservation Fund (LWCF) funding through annual appropriations from Congress. This funding, which started in the 1990s, is used to support specific conservation, recreation, and related projects that enhance public access to existing public land and resources. Since 2010, approximately 2,053 acres within the Palisades subbasin have been acquired by the BLM under the LWCF. Acquired lands that were historically farmed are transformed into public parking areas, trails for hunting and hiking, and wildlife movement corridors. The BLM has already implemented and completed several water quality improvement projects designed to reduce erosion and sedimentation throughout the subbasin. One of the projects included installing a parking barrier with post and cable fencing, designating camp sites, and installing and graveling a loop road at Wolf Flats, an undeveloped recreational area.

Other types of projects implemented by BLM include installing fencing or rocks to limit motorized vehicle use within canyons, channels, and streambeds. In the near future, BLM will embark on a multiyear streambank stabilization project in conjunction with a private landowner whose property is adjacent to Conant Boat Access. As an ongoing effort, the BLM continues to collaborate and partner with private land owners to limit development on existing farms via conservation easements. BLM also collaborates with organizations, including the Boy Scouts, to improve or relocate trails (i.e., Dry Canyon Trail) and with other agencies, including the USFS, to prevent the degradation of natural resources.

5 Total Maximum Daily Loads

A TMDL prescribes an upper limit (i.e., load capacity) on discharge of a pollutant from all sources to ensure water quality standards are met. It further allocates this load capacity among the various sources of the pollutant. Pollutant sources fall into two broad classes: (1) point sources, each of which receives a wasteload allocation, and (2) nonpoint sources, each of which receives a load allocation. Natural background contributions, when present, are considered part of the load allocation but are often treated separately because they represent a part of the load not subject to control. Because of uncertainties about quantifying loads and the relation of specific loads to attaining water quality standards, the rules regarding TMDLs (40 CFR Part 130) require a margin of safety be included in the TMDL. Practically, the margin of safety and natural background are both reductions in the load capacity available for allocation to pollutant sources.

Load capacity can be summarized by the following equation:

LC = MOS + NB + LA + WLA = TMDL

Where:

LC = load capacity
MOS = margin of safety
NB = natural background
LA = load allocation
WLA = wasteload allocation

The equation is written in this order because it represents the logical order in which a load analysis is conducted. First, the load capacity is determined. Then the load capacity is broken down into its components. After the necessary margin of safety and natural background, if relevant, are quantified, the remainder is allocated among pollutant sources (i.e., the load allocation and wasteload allocation). When the breakdown and allocation are complete, the result is a TMDL, which must equal the load capacity.

The load capacity must be based on critical conditions—the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will be more than protective under other conditions. Because both load capacity and pollutant source loads vary, and not necessarily in concert, determining critical conditions can be more complicated than it may initially appear.

Another step in a load analysis is quantifying current pollutant loads by source. This step allows for the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary for pollutant trading to occur. A load is fundamentally a quantity of pollutant discharged over some period of time and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for "other appropriate measures" to be used when necessary (40 CFR 130.2). These other measures must still be quantifiable and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads and allow "gross allotment" as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

5.1 Instream Water Quality Targets

For the Palisades subbasin temperature TMDL and 5-year review, a PNV approach was used. The Idaho water quality standards include a provision (IDAPA 58.01.02.200.09) that if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered a violation of water quality standards. In these situations, natural conditions essentially become the water quality standard, and for temperature TMDLS, the natural level of shade and channel width become the TMDL target. The instream temperature that results from attaining these conditions is consistent with the water quality standards, even if it exceeds numeric temperature criteria. See Appendix B for further discussion of water quality standards and natural background provisions.

The PNV approach is described briefly below. The procedures and methodologies to develop PNV target shade levels and to estimate existing shade levels are described in detail in *The Potential Natural Vegetation (PNV) Temperature Total Maximum Daily Load (TMDL) Procedures Manual* (Shumar and De Varona 2009). The manual also provides a more complete discussion of shade and its effects on stream water temperature.

5.1.1 Factors Controlling Water Temperature in Streams

There are several important contributors of heat to a stream, including ground water temperature, air temperature, and direct solar radiation (Poole and Berman 2001). Of these, direct solar radiation is the source of heat that is most controllable. The parameters that affect the amount of solar radiation hitting a stream throughout its length are shade and stream morphology. Shade is provided by the surrounding vegetation and other physical features such as hillsides, canyon walls, terraces, and high streambanks. Stream morphology (i.e., structure) affects riparian vegetation density and water storage in the alluvial aquifer. Riparian vegetation and channel morphology are the factors influencing shade that are most likely to have been influenced by anthropogenic activities and can be most readily corrected and addressed by a TMDL.

Riparian vegetation provides a substantial amount of shade on a stream by virtue of its proximity. However, depending on how much vertical elevation surrounds the stream, vegetation further away from the riparian corridor can also provide shade. The amount of shade that a stream receives can be measured in a number of ways. Effective shade (i.e., that shade provided by all objects that intercept the sun as it makes its way across the sky) can be measured in a given location with a Solar Pathfinder or with other optical equipment similar to a fish-eye lens on a camera. Effective shade can also be modeled using detailed information about riparian plants and their communities, topography, and stream aspect.

In addition to shade, canopy cover is a similar parameter that affects solar radiation. Canopy cover is the vegetation that hangs directly over the stream and can be measured using a densiometer or estimated visually either onsite or using aerial photography. All of these methods provide information about how much of the stream is covered and how much is exposed to direct solar radiation.

5.1.2 PNV for Temperature TMDLs

PNV along a stream is that riparian plant community that could grow to an overall mature state, although some level of natural disturbance is usually included in the development and use of shade targets. Vegetation can be removed by disturbance either naturally (e.g., wildfire, disease/old age, wind damage, wildlife grazing) or anthropogenically (e.g., domestic livestock grazing, vegetation removal, erosion). The idea behind PNV as targets for temperature TMDLs is that PNV provides a natural level of solar loading to the stream without any anthropogenic removal of shade-producing vegetation. Vegetation levels less than PNV (with the exception of natural levels of disturbance and age distribution) result in the stream heating up from anthropogenically created additional solar inputs.

PNV (and therefore target shade) can be estimated from models of plant community structure (shade curves for specific riparian plant communities). The canopy cover or shade can then be measured or estimated. Comparing the two (target and existing shade) identifies how much excess solar load the stream is receiving and any potential to decrease solar gain. Streams disturbed by wildfire, flood, or some other natural disturbance will be at less than PNV and require time to recover. Streams that have been disturbed by human activity may require additional restoration above and beyond natural recovery.

Existing and PNV shade was converted to solar loads from data collected on flat-plate collectors at the nearest National Renewable Energy Laboratory (NREL) weather stations collecting these data. In this case, the Pocatello, Idaho, station was used. The difference between existing and target solar loads, assuming existing load is higher, is the load reduction necessary to bring the stream back into compliance with water quality standards (Appendix B).

PNV shade and the associated solar loads are assumed to be the natural condition; thus, stream temperatures under PNV conditions are assumed to be natural (so long as no point sources or other anthropogenic sources of heat exist in the watershed) and are considered to be consistent with the Idaho water quality standards, even if they exceed numeric criteria by more than 0.3 °C.

5.1.2.1 Existing Shade Estimates

Existing shade was estimated for 4 AUs from visual interpretation of aerial photos. Estimates of existing shade based on plant type and density were marked out as stream segments on a 1:100,000 or 1:250,000 hydrography taking into account natural breaks in vegetation density. Stream segment length for each estimate of existing shade varies depending on the land use or landscape that has affected that shade level. Each segment was assigned a single value representing the bottom of a 10% shade class (adapted from the cumulative watershed effects process, IDL 2000). For example, if shade for a particular stream segment was estimated between 50% and 59%, a 50% shade class was assigned to that segment. Doing so provides an inherent margin of safety to the resulting TMDL. The estimate is based on a general intuitive observation about the kind of vegetation present, its density, and stream width. Streams where the streambanks and water are clearly visible are usually in low shade classes (10%, 20%, or 30%). Streams with dense forest or heavy brush where no portion of the stream is visible are usually in high shade classes (70%, 80%, or 90%). More open canopies where portions of the stream may be visible usually fall into moderate shade classes (40%, 50%, or 60%).

Visual estimates made from aerial photos are strongly influenced by canopy cover and do not always take into account topography or any shading that may occur from physical features other than vegetation. It is not always possible to visualize or anticipate shade characteristics resulting from topography and landform. However, research shows that shade and canopy cover measurements are remarkably similar (OWEB 2001), reinforcing the idea that riparian vegetation and objects proximal to the stream provide the most shade. The visual estimates of shade in this TMDL were partially field verified with a Solar Pathfinder, which measures effective shade and takes into consideration other physical features that block the sun from hitting the stream surface (e.g., hillsides, canyon walls, terraces, and man-made structures).

Solar Pathfinder Field Verification

The accuracy of the aerial photo interpretations was field verified with a Solar Pathfinder at three sites. The Solar Pathfinder is a device that allows one to trace the outline of shade-producing objects on monthly solar path charts. The percentage of the sun's path covered by these objects is the effective shade on the stream at the tracing location. To adequately characterize the effective shade on a stream segment, 20 traces were taken at systematic or random intervals along the length of the stream.

At each sampling location, the Solar Pathfinder was placed in the middle of the stream at the bankfull water level. Following the manufacturer's instructions (i.e., orient to south and level), 20 traces were taken. Systematic sampling was used because it is easiest to accomplish without biasing the sampling location. For each sampled segment, the sampler started at a unique location, such as 25 to 50 meters (m) from a bridge or fence line, and proceeded upstream or downstream taking additional traces at fixed intervals (e.g., every 25 m, 25 paces, etc.). Alternatively, one can randomly locate points of measurement by generating random numbers to be used as interval distances.

When possible, the sampler also measured bankfull widths, took notes, and photographed the landscape of the stream at several unique locations while taking traces. Special attention was given to changes in riparian plant communities and the kinds of plant species present (the large, dominant, shade-producing ones). Densiometer readings can also be taken at the same location as Solar Pathfinder traces. These readings provide the potential to develop relationships between canopy cover and effective shade for a given stream.

In general, Solar Pathfinder data showed that aerial interpretations were reasonably accurate, with an average underestimation of -0.33 ± 1.7 (average ± 95% C.I.) (Table 10). At one site, aerial interpretation underestimated shade by two classes. At another, shade was over estimated by one class. At the third site, the correct shade class was identified. These data were used to correct interpretations in those locations and to "calibrate our eyes" for further evaluation in other areas of the shade analysis.

Table 10. Solar Pathfinder results for three sites within the Palisades subbasin.

Water Body and Assessment Unit	Aerial Class	Pathfinder Actual	Pathfinder Class	Delta	
Gibson Creek ID17040104SK006_02	50	73	70	-2	
Gibson Creek ID17040104SK006_03	60	65	60	0	
Fall Creek ID17040104SK006_04	40	33	30	1	
				-0.33	Average
				1.5	Standard Deviation
				1.7	95% Confidence Interval

5.1.2.2 Target Shade Determination

PNV targets were determined from an analysis of probable vegetation at the streams and comparing that to shade curves developed for similar vegetation communities in Idaho (Shumar and De Varona 2009). A shade curve shows the relationship between effective shade and stream width. As a stream gets wider, shade decreases as vegetation has less ability to shade the center of wide streams. As the vegetation gets taller, the more shade the plant community is able to provide at any given channel width.

Natural Bankfull Widths

Stream width must be known to calculate target shade since the width of a stream affects the amount of shade the stream receives. Bankfull width is used because it best approximates the width between the points on either side of the stream where riparian vegetation starts. Measures of current bankfull width may not reflect widths present under PNV (i.e., natural widths). As impacts to streams and riparian areas occur, width-to-depth ratios tend to increase such that streams become wider and shallower. Shade produced by vegetation covers a lower percentage of the water surface in wider streams, and widened streams can also have less vegetative cover if shoreline vegetation has eroded away.

Since existing bankfull width may not be discernible from aerial photo interpretation and may not reflect natural bankfull widths, this parameter must be estimated from available information. Regional curves for the major basins in Idaho were used (Shumar and De Varona 2009). The curves were developed from data compiled by Diane Hopster of the Idaho Department of Lands to estimate natural bankfull width (Figure 18).

For each stream evaluated in the load analysis, natural bankfull width was estimated based on the drainage area of the Upper Snake curve (Figure 18). Although estimates from other curves were examined (i.e., Salmon, Payette/Weiser), the Upper Snake curve was ultimately chosen because of its proximity to the Palisades subbasin and similarity of climate. Existing width data should also be evaluated and compared to these curve estimates if such data are available. However, for the Palisades subbasin, only a few BURP sites exist, and bankfull width data from those sites represent spot data (e.g., only three measured widths in a reach just several hundred meters long) that are not always representative of the stream as a whole.

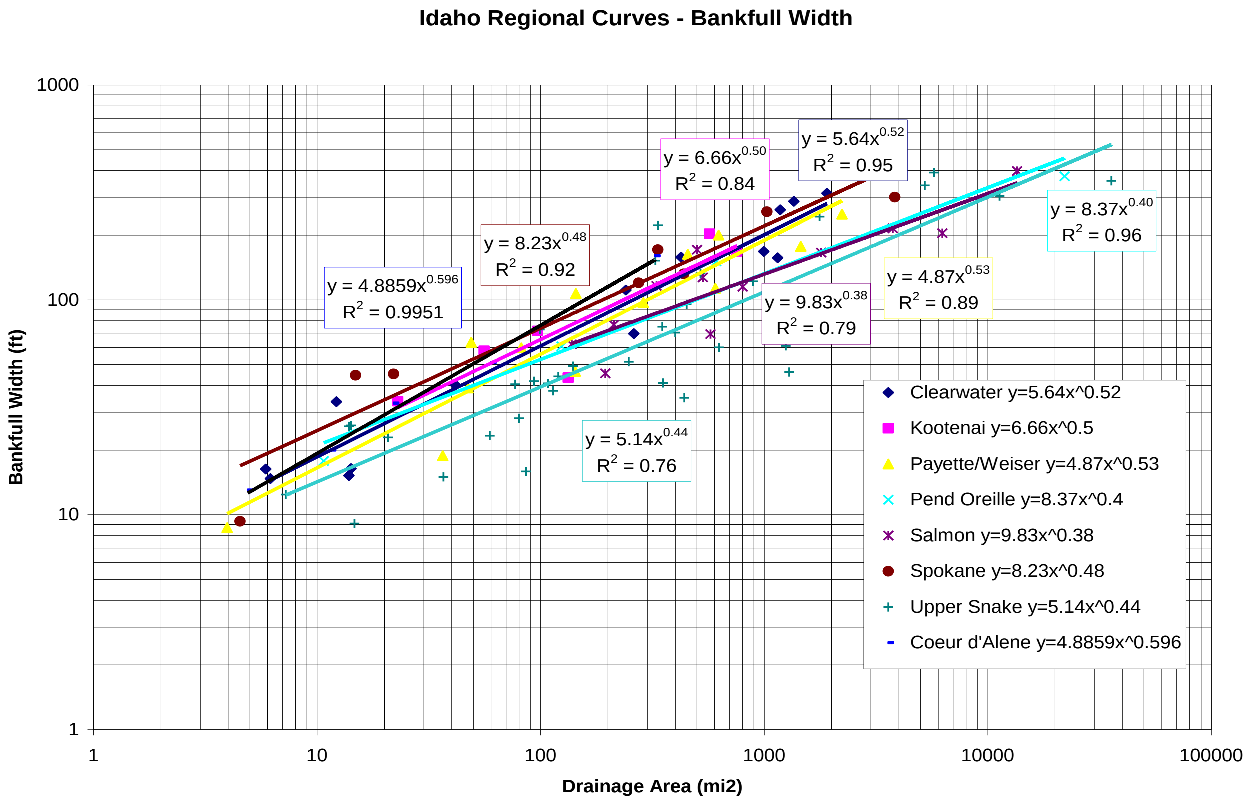

Figure 18. Bankfull width as a function of drainage area.

In general, BURP bankfull width data agreed with natural bankfull width estimates from the Upper Snake curve, so natural widths were not made any smaller than these estimates. Natural bankfull width estimates for each stream in this analysis are presented in Table 11. Figure 19 shows the relationship of measured BURP bankfull widths to the Upper Snake curve. These BURP data are consistent with the hydrologic data used to generate the Upper Snake curve. The load analysis tables contain a natural bankfull width and an existing bankfull width for every stream segment in the analysis based on the bankfull width results presented in Table 11. Existing widths and natural widths are the same in load tables when no data exist to support making them differ.

Table 11. Bankfull width estimates from regional curves and BURP data for the Palisades subbasin.

Location	Area (square miles)	Upper Snake (meters)	Salmon (meters)	Payette/ Weiser (meters)	BURP Width Measurement (meters)	Year Measured
Fall Creek above South Fork Fall Creek (bottom of 04 AU)	51.74	9	13	12	6	1993
Fall Creek below Gibson Creek	41.57	8	12	11	—	—
Fall Creek above Gibson Creek	31.34	7	11	9	5	2001
					8	1996
Fall Creek above Trap Creek	22.02	6	10	8	—	—
Fall Creek below Beaver Creek (top of 04 AU)	19.12	6	9	7	—	—
Fall Creek above East Fork Fall Creek (bottom of 03 AU)	10.01	4	7	5	—	—
Fall Creek (top of 03 AU)	3.23	3	5	3	—	—
Gibson Creek at mouth	10.23	4	7	5	—	—
Gibson Creek below June Creek (top of 03 AU)	7.71	4	7	4	—	—
Gibson Creek above June Creek	3.00	3	5	3	3	1996
					1.5	2010
June Creek at mouth	4.71	3	5	3	Dry	—
East Fork Fall Creek at mouth	6.56	4	6	4	—	—
Beaver Creek at mouth	2.55	2	4	2	—	—
Trap Creek at mouth	1.11	2	3	2	—	—
Haskins Creek at mouth	2.75	2	4	3	—	—
Camp Creek at mouth	3.81	3	5	3	4	1997
Blacktail Canyon at mouth	2.22	2	4	2	—	—
Rash Canyon at mouth	3.14	3	5	3	—	—
Rainey Creek at mouth	75.31	10	15	15	—	—
Rainey Creek below Swan Valley slough	52.75	9	14	12	10	1998
Rainey Creek at Forest Service boundary	36.81	8	12	10	9	1996
					6	2008
					5	2013
Rainey Creek below Spring Canyon (04 AU top)	28.07	7	11	9	7	2016

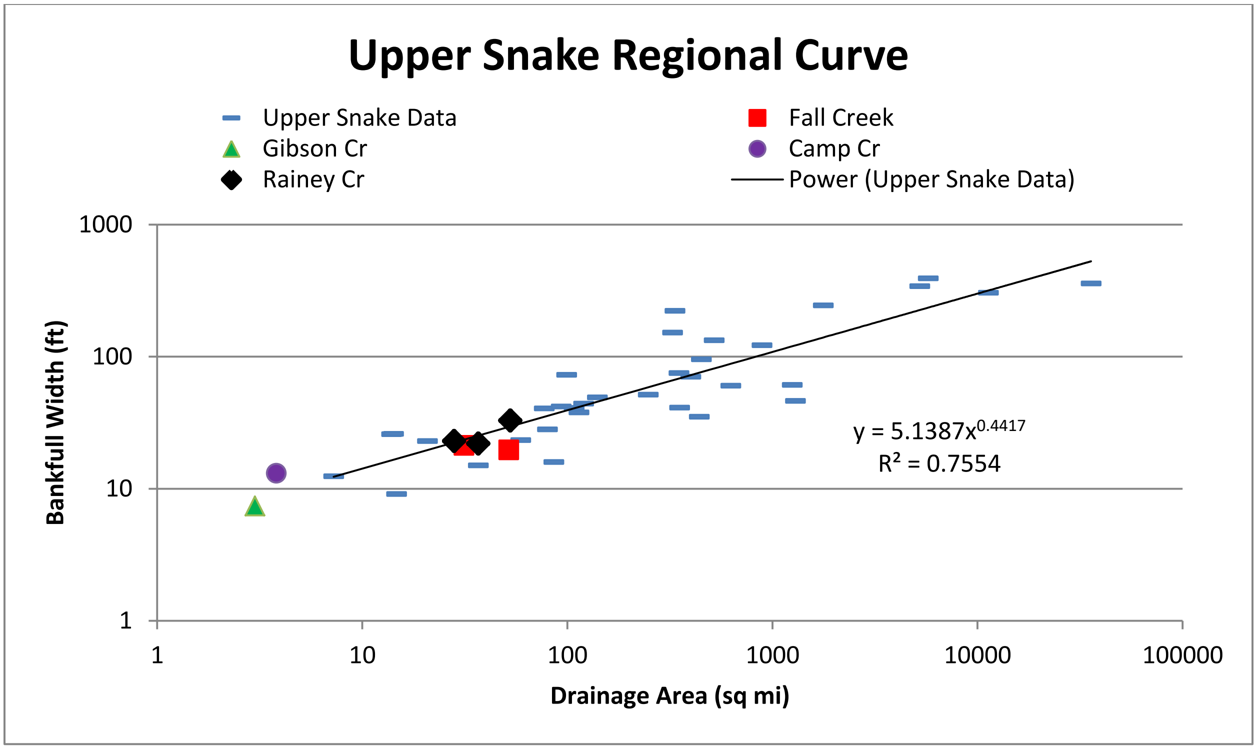

Figure 19. BURP bankfull width data as a function of drainage area.

5.1.3 Design Conditions

The Palisades subbasin is generally within the Partly Forested Mountains level 4 subecoregion of the Middle Rockies ecoregion (McGrath et al. 2001). This subecoregion is known for its open-canopied forests, shrublands, and grasslands on cryic, rocky, and shallow soils. Douglas-fir, lodgepole pine, and aspens are found on north-facing slopes and uplands, whereas mountain big sagebrush and mountain brush communities dominate on south-facing slopes.

The valley floor below the Palisades Reservoir to Swan Valley is within the Cold Valleys level 4 subecoregion. These predominantly sagebrush covered bottomlands, terraces, marshlands, and alluvial fans have a frost-free period of only 40–90 days. Wet bottomlands tend to support sedges, rushes, and willows.

5.1.4 Shade Curve Selection

To determine PNV shade targets for the Fall Creek AUs (ID17040104SK006_02, ID17040104SK006_03, and ID17040104SK006_04) and Rainey Creek (ID17040104SK028_04), effective shade curves from the Targhee National Forest group were examined (Table 12) (Shumar and De Varona 2009). These curves were produced using vegetation community modeling of Idaho plant communities. Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis. For the Fall Creek AUs and Rainey Creek, curves for the most similar vegetation type were selected for shade target determinations.

To determine appropriate shade targets for these streams, the locations of various ecological units as described by the Targhee National Forest Ecological Unit Inventory (Bowerman et al.

1999) were evaluated. Shade curves were developed for some of these specific Targhee ecological units based on species compositions (cover and constancy data) provided in the inventory (Shumar and De Varona 2009). Ecological Unit (EU) #1303 is the dominant forest type in the upper Fall Creek area; however, no shade curve exists for that specific unit. Therefore, EU #1315 was used as a similar unit to stand in for shade target development. Riparian areas in upper Fall Creek are within EU #2606. As these areas widen further downstream, the Geyer willow shade curve from the southern Idaho shrub dominated group of shade curves was applied. Smaller tributaries may also have occasional locations in sage/grass or aspen. The Rainey Creek AU on the other side of the Snake River valley has potential vegetation dominated by Geyer willow in the upper reaches and bottomlands with narrowleaf cottonwood on the alluvial middle reaches.

Table 12. Shade target curves for the vegetation types used in this TMDL.

Targhee National Forest Ecological Units	Southern Idaho Shrub communities
EU #1315 (replacing EU #1303)	Geyer willow
EU #2606	Aspen
	Sage/grass
	Narrowleaf cottonwood

Shade curves for the various EUs and shrub communities (Table 12) are presented in Appendix C. The Targhee EUs used in this analysis are described next.

EU #1315 is found on foothills and mountains in the warm portion of the forested zone (Bowerman et al. 1999). The topography is described as hilly slopes that are slightly to moderately dissected by incised drainageways. The drainageways have dry, south-facing and moist, north-facing sideslopes. Summits between drainageways support forests with variable canopy cover of mixed conifers and quaking aspens. Diverse communities dominated by shrubs and grasses with widely dispersed conifers are supported on south-facing drainage sideslopes. Closed canopy forests are supported on north-facing drainage sideslopes. Subalpine fir/sweet cicely or subalpine fir/blue huckleberry are the dominant PNV on 65% of the area, with various combinations of Douglas-fir, aspen, and mountain big sagebrush types making up the remaining 35%. Vegetation data used to develop the shade curve were dominated by subalpine fir, Douglas-fir, aspen, and lodgepole pine (Shumar and De Varona 2009). Common shrubs included snowberry, serviceberry, and ceanothus.

EU #2606 is a riparian unit dominated by willows and grasses (Bowerman et al. 1999) and found throughout the shrub steppe and forested zones on moist floodplains. The topography can be flat bottom valleys with low to moderate gradient, narrow to broad width floodplains in foothills, and dissected tablelands. Channel incision and beaver activity strongly influence the hydrology of these systems. The dominant shade-producing vegetation include Booth's willow, Geyer willow, Drummond's willow, coyote willow, Lemmon's willow, and graminoids (Shumar and De Varona 2009).

5.1.5 Water Quality Monitoring Points

A robust riparian canopy aimed at preventing excess solar loads to streams is essential to the successful implementation of the PNV temperature TMDL presented in this document. During a future 5-year review cycle, shade monitoring along any segment of an AU through Solar Pathfinder data collection will confirm progress made toward maintaining or achieving the shade targets provided in the TMDLs. DEQ's existing methods and quality assurance programs outline required elements for both the monitoring plans and beneficial use assessments.

5.2 Load Capacity

The load capacity for a stream under PNV is essentially the solar loading allowed under the shade targets specified for the segments within that stream. These loads are determined by multiplying the solar load measured by a flat-plate collector (under full sun) for a given period of time by the fraction of the solar radiation that is not blocked by shade (i.e., the percent open or 100% minus percent shade). In other words, if a shade target is 60% (or 0.6), the solar load hitting the stream under that target is 40% of the load hitting the flat-plate collector under full sun.

Solar load data were obtained from flat-plate collectors at the NREL weather station in Pocatello, Idaho. The solar load data used in this TMDL analysis are spring/summer averages (i.e., an average load for the 6-month period from April through September). As such, load capacity calculations are also based on this 6-month period, which coincides with the time of year when stream temperatures are warmest, deciduous vegetation is in leaf, and fall spawning is occurring (Table 13). During this period, temperatures may affect beneficial uses such as spring and fall salmonid spawning and cold water aquatic life. Late July and early August typically represent the period of highest stream temperatures. However, solar gains can begin early in the spring and affect not only the highest temperatures reached later in the summer but also spawning temperatures in spring and fall.

Table 13. Target vs. current solar loads from nonpoint sources in the Palisades subbasin.

Load Type	Assessment Unit Name/Number	Target Load (kWh/day)	Current Load (kWh/day)	Estimation Method	TMDL Required
6-month average heat load	Fall Creek—source to South Fork Fall Creek, ID17040104SK006_02	330,000	270,000	Existing shade analysis	No
6-month average heat load	Fall Creek—source to South Fork Fall Creek, ID17040104SK006_03	94,000	60,000	Existing shade analysis	No
6-month average heat load	Fall Creek—source to South Fork Fall Creek, ID17040104SK006_04	350,000	310,000	Existing shade analysis	No
6-month average heat load	Rainey Creek—source to mouth, ID17040104SK028_04	570,000	780,000	Existing shade analysis	Yes

Table 14–Table 17 and Figure 20 and Figure 23 show the PNV shade targets. The tables also show corresponding target summer loads (in kilowatt-hours per square meter per day

[kWh/m^2/day] and kilowatt-hours per day [kWh/day]) that serve as the load capacities for the streams. Existing and target loads in kWh/day can be summed for the entire stream or portion of stream examined in a single load analysis table. These total loads are shown at the bottom of their respective columns in each table. Because load calculations involve stream segment area calculations, the segment's channel width, which typically has only one or two significant figures, dictates the level of significance of the corresponding loads. One significant figure in the resulting load can create rounding errors when existing and target loads are subtracted. The totals row of each load table represents total loads with two significant figures in an attempt to reduce apparent rounding errors.

The AU with the largest target load (i.e., load capacity) was the Rainey Creek AU (ID17040104SK028_04) with 570,000 kWh/day (Table 17). The smallest target load was in the 3rd order of Fall Creek (ID17040104SK006_03) with 94,000 kWh/day (Table 15).

See section 2 for temperature data corresponding to PNV information presented here.

5.3 Estimates of Existing Pollutant Loads

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading" (40 CFR 130.2(g)).

Existing loads in this temperature TMDL come from estimates of existing shade as determined from aerial photo interpretations (Figure 21; Figure 24). No known permitted point sources exist in the affected AUs. Like target shade, existing shade was converted to a solar load by multiplying the fraction of open stream by the solar radiation measured on a flat-plate collector at the NREL weather station. Existing shade data are presented in Table 14–Table 17. Like load capacities (target loads), existing loads in Table 14–Table 17 are presented on an area basis (kWh/m^2/day) and as a total load (kWh/day). Existing loads in kWh/day are also summed for the entire stream or portion of stream examined in a single load analysis table. The difference between target and existing load is also summed for the entire table. Should existing load exceed target load, this difference becomes the excess load (i.e., shade deficit) to be discussed next in the load allocation section and as depicted in the shade deficit figures (Figure 22 and Figure 25).

The AU with the largest existing load was the Rainey Creek AU (ID 17040104SK028_04) with 780,000 kWh/day (Table 17). The smallest existing load was in the 3rd order of Fall Creek (ID17040104SK006_03) with 60,000 kWh/day (Table 15).

Table 14. Existing and target solar loads for the 4th-order assessment unit of Fall Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
006_04	Fall Creek	1	180	Geyer willow	39%	3.75	6	1,000	4,000	70%	1.85	6	1,000	2,000	(2,000)	0%
006_04	Fall Creek	2	420	Geyer willow	39%	3.75	6	3,000	10,000	60%	2.46	6	3,000	7,000	(3,000)	0%
006_04	Fall Creek	3	1000	Geyer willow	39%	3.75	6	6,000	20,000	40%	3.69	6	6,000	20,000	0	0%
006_04	Fall Creek	4	420	Geyer willow	39%	3.75	6	3,000	10,000	40%	3.69	6	3,000	10,000	0	0%
006_04	Fall Creek	5	920	Geyer willow	39%	3.75	6	6,000	20,000	30%	4.31	6	6,000	30,000	10,000	-9%
006_04	Fall Creek	6	540	Geyer willow	35%	4.00	7	4,000	20,000	40%	3.69	7	4,000	10,000	(10,000)	0%
006_04	Fall Creek	7	440	Geyer willow	35%	4.00	7	3,000	10,000	40%	3.69	7	3,000	10,000	0	0%
006_04	Fall Creek	8	110	Geyer willow	35%	4.00	7	800	3,000	40%	3.69	7	800	3,000	0	0%
006_04	Fall Creek	9	860	Geyer willow	35%	4.00	7	6,000	20,000	20%	4.92	7	6,000	30,000	10,000	-15%
006_04	Fall Creek	10	1000	Geyer willow	35%	4.00	7	7,000	30,000	20%	4.92	7	7,000	30,000	0	-15%
006_04	Fall Creek	11	480	Geyer willow	35%	4.00	7	3,000	10,000	30%	4.31	7	3,000	10,000	0	-5%
006_04	Fall Creek	12	1000	Geyer willow	32%	4.18	8	8,000	30,000	30%	4.31	8	8,000	30,000	0	-2%
006_04	Fall Creek	13	140	Geyer willow	32%	4.18	8	1,000	4,000	40%	3.69	8	1,000	4,000	0	0%
006_04	Fall Creek	14	730	Geyer willow	32%	4.18	8	6,000	30,000	40%	3.69	8	6,000	20,000	(10,000)	0%
006_04	Fall Creek	15	730	Geyer willow	32%	4.18	8	6,000	30,000	30%	4.31	8	6,000	30,000	0	-2%
006_04	Fall Creek	16	270	Geyer willow	28%	4.43	9	2,000	9,000	40%	3.69	9	2,000	7,000	(2,000)	0%
006_04	Fall Creek	17	200	Geyer willow	28%	4.43	9	2,000	9,000	30%	4.31	9	2,000	9,000	0	0%
006_04	Fall Creek	18	1300	Geyer willow	28%	4.43	9	10,000	40,000	50%	3.08	9	10,000	30,000	(10,000)	0%
006_04	Fall Creek	19	470	Geyer willow	28%	4.43	9	4,000	20,000	40%	3.69	9	4,000	10,000	(10,000)	0%
006_04	Fall Creek	20	420	Geyer willow	28%	4.43	9	4,000	20,000	50%	3.08	9	4,000	10,000	(10,000)	0%
							Totals		350,000					310,000	0	

Note: All AU numbers start with ID17040104SK in all load tables (Table 14–Table 17). Significant figures are determined by the lowest level in the calculation, typically that of the channel width. Some rounding errors may result.

Table 15. Existing and target solar loads for the 3rd-order assessment unit of Fall Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
006_03	Fall Creek	1	140	TNF #2606	43%	3.51	3	400	1,000	80%	1.23	3	400	500	(500)	0%
006_03	Fall Creek	2	1370	TNF #2606	43%	3.51	3	4,000	10,000	70%	1.85	3	4,000	7,000	(3,000)	0%
006_03	Fall Creek	4	210	TNF #2606	43%	3.51	3	600	2,000	60%	2.46	3	600	1,000	(1,000)	0%
006_03	Fall Creek	5	760	TNF #2606	43%	3.51	3	2,000	7,000	70%	1.85	3	2,000	4,000	(3,000)	0%
006_03	Fall Creek	6	1100	TNF #2606	43%	3.51	3	3,000	10,000	60%	2.46	3	3,000	7,000	(3,000)	0%
006_03	Fall Creek	7	700	TNF #2606	43%	3.51	3	2,000	7,000	70%	1.85	3	2,000	4,000	(3,000)	0%
006_03	Fall Creek	8	240	TNF #2606	35%	4.00	4	1,000	4,000	70%	1.85	4	1,000	2,000	(2,000)	0%
006_03	Fall Creek	9	730	TNF #2606	35%	4.00	4	3,000	10,000	50%	3.08	4	3,000	9,000	(1,000)	0%
006_03	EF Fall Creek	1	680	TNF #2606	35%	4.00	4	3,000	10,000	70%	1.85	4	3,000	6,000	(4,000)	0%
006_03	EF Fall Creek	2	190	TNF #2606	35%	4.00	4	800	3,000	80%	1.23	4	800	1,000	(2,000)	0%
006_03	Gibson Creek	1	430	TNF #2606	35%	4.00	4	2,000	8,000	60%	2.46	4	2,000	5,000	(3,000)	0%
006_03	Gibson Creek	2	480	TNF #2606	35%	4.00	4	2,000	8,000	70%	1.85	4	2,000	4,000	(4,000)	0%
006_03	Gibson Creek	3	700	TNF #2606	35%	4.00	4	3,000	10,000	60%	2.46	4	3,000	7,000	(3,000)	0%
006_03	Gibson Creek	4	350	TNF #2606	35%	4.00	4	1,000	4,000	70%	1.85	4	1,000	2,000	(2,000)	0%
							Totals		94,000					60,000	0	

Table 16. Existing and target solar loads for the 2nd-order assessment unit of Fall Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
006_02	Fall Creek	1	1100	TNF #1315	80%	1.23	1	1,000	1,000	80%	1.23	1	1,000	1,000	0	0%
006_02	Fall Creek	2	1600	TNF #1315	78%	1.35	2	3,000	4,000	80%	1.23	2	3,000	4,000	0	0%
006_02	1st to Fall	1	1100	TNF #1315	80%	1.23	1	1,000	1,000	90%	0.62	1	1,000	600	(400)	0%
006_02	2nd to Fall	1	2200	TNF #1315	78%	1.35	2	4,000	5,000	90%	0.62	2	4,000	2,000	(3,000)	0%
006_02	2nd to Fall	2	770	TNF #1315	78%	1.35	2	2,000	3,000	80%	1.23	2	2,000	2,000	(1,000)	0%
006_02	1st to 2nd	1	1500	TNF #1315	80%	1.23	1	2,000	2,000	90%	0.62	1	2,000	1,000	(1,000)	0%
006_02	3rd to Fall	1	1900	TNF #1315	78%	1.35	2	4,000	5,000	90%	0.62	2	4,000	2,000	(3,000)	0%
006_02	4th to Fall	1	1500	TNF #1315	80%	1.23	1	2,000	2,000	90%	0.62	1	2,000	1,000	(1,000)	0%
006_02	4th to Fall	2	830	TNF #1315	78%	1.35	2	2,000	3,000	80%	1.23	2	2,000	2,000	(1,000)	0%
006_02	5th to Fall	1	1100	TNF #1315	80%	1.23	1	1,000	1,000	90%	0.62	1	1,000	600	(400)	0%
006_02	6th to Fall	1	890	TNF #1315	80%	1.23	1	900	1,000	90%	0.62	1	900	600	(400)	0%
006_02	6th to Fall	2	1100	TNF #2606	58%	2.58	2	2,000	5,000	80%	1.23	2	2,000	2,000	(3,000)	22%
006_02	7th to Fall	1	2200	TNF #1315	80%	1.23	1	2,000	2,000	90%	0.62	1	2,000	1,000	(1,000)	0%
006_02	7th to Fall	2	960	TNF #2606	58%	2.58	2	2,000	5,000	80%	1.23	2	2,000	2,000	(3,000)	0%
006_02	7th to Fall	3	38	beaver pond	0%	6.15	2	80	500	0%	6.15	2	80	500	0	0%
006_02	7th to Fall	4	700	TNF #2606	58%	2.58	2	1,000	3,000	70%	1.85	2	1,000	2,000	(1,000)	0%
006_02	8th to Fall	1	1200	TNF #1315	80%	1.23	1	1,000	1,000	90%	0.62	1	1,000	600	(400)	0%
006_02	8th to Fall	2	530	TNF #2606	88%	0.74	1	500	400	80%	1.23	1	500	600	200	-8%
006_02	8th to Fall	3	37	TNF #2606	58%	2.58	2	70	200	0%	6.15	2	70	400	200	-58%
006_02	8th to Fall	4	750	TNF #2606	58%	2.58	2	2,000	5,000	80%	1.23	2	2,000	2,000	(3,000)	0%
006_02	Beaver Creek	1	1200	TNF #1315	80%	1.23	1	1,000	1,000	90%	0.62	1	1,000	600	(400)	0%
006_02	Beaver Creek	2	930	TNF #2606	88%	0.74	1	900	700	80%	1.23	1	900	1,000	300	-8%
006_02	Beaver Creek	3	3280	TNF #2606	58%	2.58	2	7,000	20,000	80%	1.23	2	7,000	9,000	(10,000)	0%
006_02	1st to Beaver	1	1200	TNF #1315	80%	1.23	1	1,000	1,000	90%	0.62	1	1,000	600	(400)	0%
006_02	East Fork Fall Creek	1	2800	TNF #1315	80%	1.23	1	3,000	4,000	80%	1.23	1	3,000	4,000	0	0%
006_02	East Fork Fall Creek	2	1300	TNF #1315	78%	1.35	2	3,000	4,000	90%	0.62	2	3,000	2,000	(2,000)	0%
006_02	East Fork Fall Creek	3	1900	TNF #1315	67%	2.03	3	6,000	10,000	80%	1.23	3	6,000	7,000	(3,000)	0%
006_02	East Fork Fall Creek	4	220	TNF #1315	57%	2.64	4	900	2,000	70%	1.85	4	900	2,000	0	0%
006_02	East Fork Fall Creek	5	410	TNF #1315	57%	2.64	4	2,000	5,000	90%	0.62	4	2,000	1,000	(4,000)	0%
006_02	East Fork Fall Creek	6	700	TNF #2606	35%	4.00	4	3,000	10,000	70%	1.85	4	3,000	6,000	(4,000)	0%
006_02	1st to EF	1	1400	TNF #1315	80%	1.23	1	1,000	1,000	90%	0.62	1	1,000	600	(400)	0%
006_02	2nd to EF	1	1400	TNF #1315	80%	1.23	1	1,000	1,000	90%	0.62	1	1,000	600	(400)	0%
006_02	3rd to EF	1	1400	TNF #1315	80%	1.23	1	1,000	1,000	90%	0.62	1	1,000	600	(400)	0%
006_02	3rd to EF	2	890	TNF #2606	58%	2.58	2	2,000	5,000	70%	1.85	2	2,000	4,000	(1,000)	0%
006_02	3rd to EF	3	53	beaver pond	0%	6.15	2	100	600	0%	6.15	2	100	600	0	0%
006_02	3rd to EF	4	620	TNF #2606	58%	2.58	2	1,000	3,000	70%	1.85	2	1,000	2,000	(1,000)	0%
006_02	1st to 3rd to EF	1	1100	TNF #1315	80%	1.23	1	1,000	1,000	90%	0.62	1	1,000	600	(400)	0%
006_02	1st to 3rd to EF	2	390	TNF #2606	88%	0.74	1	400	300	80%	1.23	1	400	500	200	-8%
006_02	Willow Springs Creek	1	550	TNF #2606	88%	0.74	1	600	400	70%	1.85	1	600	1,000	600	-18%
006_02	Willow Springs Creek	2	670	TNF #2606	88%	0.74	1	700	500	80%	1.23	1	700	900	400	-8%
006_02	Willow Springs Creek	3	340	TNF #1315	80%	1.23	1	300	400	90%	0.62	1	300	200	(200)	0%
006_02	Willow Springs Creek	4	1300	TNF #2606	58%	2.58	2	3,000	8,000	70%	1.85	2	3,000	6,000	(2,000)	0%

Table 15 (cont.). Existing and target solar loads for the 2nd-order assessment unit of Fall Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/ day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/ day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
006_02	9th to Fall	1	700	TNF #1315	80%	1.23	1	700	900	90%	0.62	1	700	400	(500)	0%
006_02	9th to Fall	2	250	TNF #1315	80%	1.23	1	300	400	80%	1.23	1	300	400	0	0%
006_02	9th to Fall	3	1100	TNF #2606	58%	2.58	2	2,000	5,000	50%	3.08	2	2,000	6,000	1,000	-8%
006_02	Trap Creek	1	900	TNF #1315	80%	1.23	1	900	1,000	90%	0.62	1	900	600	(400)	0%
006_02	Trap Creek	2	550	TNF #1315	80%	1.23	1	600	700	80%	1.23	1	600	700	0	0%
006_02	Trap Creek	3	1800	TNF #2606	58%	2.58	2	4,000	10,000	70%	1.85	2	4,000	7,000	(3,000)	0%
006_02	10th to Fall	1	1100	TNF #1315	80%	1.23	1	1,000	1,000	90%	0.62	1	1,000	600	(400)	0%
006_02	10th to Fall	2	890	TNF #2606	88%	0.74	1	900	700	70%	1.85	1	900	2,000	1,000	-18%
006_02	10th to Fall	3	380	sage/grass	65%	2.15	1	400	900	30%	4.31	1	400	2,000	1,000	-35%
006_02	11th to Fall	1	870	TNF #2606	88%	0.74	1	900	700	50%	3.08	1	900	3,000	2,000	-38%
006_02	11th to Fall	2	1100	sage/grass	65%	2.15	1	1,000	2,000	30%	4.31	1	1,000	4,000	2,000	-35%
006_02	Haskin Creek	1	1500	TNF #1315	80%	1.23	1	2,000	2,000	90%	0.62	1	2,000	1,000	(1,000)	0%
006_02	Haskin Creek	2	790	TNF #1315	80%	1.23	1	800	1,000	80%	1.23	1	800	1,000	0	0%
006_02	Haskin Creek	3	490	TNF #2606	88%	0.74	1	500	400	50%	3.08	1	500	2,000	2,000	-38%
006_02	Haskin Creek	4	890	TNF #2606	58%	2.58	2	2,000	5,000	70%	1.85	2	2,000	4,000	(1,000)	0%
006_02	Haskin Creek	5	390	TNF #2606	58%	2.58	2	800	2,000	50%	3.08	2	800	2,000	0	-8%
006_02	Haskin Creek	6	590	TNF #2606	58%	2.58	2	1,000	3,000	60%	2.46	2	1,000	2,000	(1,000)	0%
006_02	Haskin Creek	7	410	TNF #2606	58%	2.58	2	800	2,000	80%	1.23	2	800	1,000	(1,000)	0%
006_02	Haskin Creek	8	190	TNF #2606	58%	2.58	2	400	1,000	50%	3.08	2	400	1,000	0	-8%
006_02	Haskin Creek	9	210	TNF #2606	58%	2.58	2	400	1,000	70%	1.85	2	400	700	(300)	0%
006_02	1st to Haskin	1	310	TNF #1315	80%	1.23	1	300	400	90%	0.62	1	300	200	(200)	0%
006_02	1st to Haskin	2	110	TNF #2606	88%	0.74	1	100	70	50%	3.08	1	100	300	200	-38%
006_02	1st to Haskin	3	87	sage/grass	65%	2.15	1	90	200	0%	6.15	1	90	600	400	-65%
006_02	1st to Haskin	4	430	sage/grass	65%	2.15	1	400	900	50%	3.08	1	400	1,000	100	-15%
006_02	1st to Haskin	5	170	TNF #1315	80%	1.23	1	200	200	90%	0.62	1	200	100	(100)	0%
006_02	1st to Haskin	6	500	sage/grass	65%	2.15	1	500	1,000	40%	3.69	1	500	2,000	1,000	-25%
006_02	Camp Creek	1	1500	TNF #1315	80%	1.23	1	2,000	2,000	90%	0.62	1	2,000	1,000	(1,000)	0%
006_02	Camp Creek	2	450	TNF #1315	80%	1.23	1	500	600	80%	1.23	1	500	600	0	0%
006_02	Camp Creek	3	1300	TNF #2606	88%	0.74	1	1,000	700	60%	2.46	1	1,000	2,000	1,000	-28%
006_02	Camp Creek	4	59	TNF #2606	58%	2.58	2	100	300	60%	2.46	2	100	200	(100)	0%
006_02	Camp Creek	5	130	TNF #2606	58%	2.58	2	300	800	30%	4.31	2	300	1,000	200	-28%
006_02	Camp Creek	6	230	TNF #2606	58%	2.58	2	500	1,000	50%	3.08	2	500	2,000	1,000	-8%
006_02	Camp Creek	7	530	beaver pond	40%	3.69	2	1,000	4,000	40%	3.69	2	1,000	4,000	0	0%
006_02	Camp Creek	8	240	TNF #2606	58%	2.58	2	500	1,000	70%	1.85	2	500	900	(100)	0%
006_02	Camp Creek	9	730	TNF #2606	58%	2.58	2	1,000	3,000	50%	3.08	2	1,000	3,000	0	-8%
006_02	Camp Creek	10	150	TNF #2606	43%	3.51	3	500	2,000	70%	1.85	3	500	900	(1,000)	0%
006_02	Camp Creek	11	850	TNF #2606	43%	3.51	3	3,000	10,000	50%	3.08	3	3,000	9,000	(1,000)	0%
006_02	Camp Creek	12	300	TNF #2606	43%	3.51	3	900	3,000	60%	2.46	3	900	2,000	(1,000)	0%
006_02	Camp Creek	13	67	TNF #2606	43%	3.51	3	200	700	40%	3.69	3	200	700	0	-3%
006_02	Camp Creek	14	800	TNF #2606	43%	3.51	3	2,000	7,000	70%	1.85	3	2,000	4,000	(3,000)	0%
006_02	1st to Camp	1	950	TNF #1315	80%	1.23	1	1,000	1,000	90%	0.62	1	1,000	600	(400)	0%
006_02	1st to Camp	2	350	TNF #2606	88%	0.74	1	400	300	70%	1.85	1	400	700	400	-18%
006_02	2nd to Camp	1	890	TNF #1315	80%	1.23	1	900	1,000	80%	1.23	1	900	1,000	0	0%
006_02	2nd to Camp	2	140	TNF #2606	88%	0.74	1	100	70	40%	3.69	1	100	400	300	-48%
006_02	2nd to Camp	3	180	sage/grass	65%	2.15	1	200	400	30%	4.31	1	200	900	500	-35%
006_02	2nd to Camp	4	220	TNF #2606	88%	0.74	1	200	100	80%	1.23	1	200	200	100	-8%
006_02	2nd to Camp	5	280	sage/grass	65%	2.15	1	300	600	40%	3.69	1	300	1,000	400	-25%

Table 15 (cont.). Existing and target solar loads for the 2nd-order assessment unit of Fall Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
006_02	Monument Creek	1	1700	TNF #2606	88%	0.74	1	2,000	1,000	80%	1.23	1	2,000	2,000	1,000	-8%
006_02	Monument Creek	2	310	sage/grass	65%	2.15	1	300	600	0%	6.15	1	300	2,000	1,000	-65%
006_02	Monument Creek	3	740	TNF #2606	58%	2.58	2	1,000	3,000	50%	3.08	2	1,000	3,000	0	-8%
006_02	Monument Creek	4	170	TNF #2606	58%	2.58	2	300	800	30%	4.31	2	300	1,000	200	-28%
006_02	Monument Creek	5	940	TNF #2606	58%	2.58	2	2,000	5,000	50%	3.08	2	2,000	6,000	1,000	-8%
006_02	Monument Creek	6	560	TNF #2606	58%	2.58	2	1,000	3,000	70%	1.85	2	1,000	2,000	(1,000)	0%
006_02	June Creek	1	410	TNF #1315	80%	1.23	1	400	500	90%	0.62	1	400	200	(300)	0%
006_02	June Creek	2	240	TNF #2606	88%	0.74	1	200	100	30%	4.31	1	200	900	800	-58%
006_02	June Creek	3	340	TNF #2606	58%	2.58	1	300	800	60%	2.46	1	300	700	(100)	0%
006_02	June Creek	4	52	TNF #2606	88%	0.74	1	50	40	0%	6.15	1	50	300	300	-88%
006_02	June Creek	5	480	TNF #1315	80%	1.23	1	500	600	80%	1.23	1	500	600	0	0%
006_02	June Creek	6	67	beaver pond	60%	2.46	1	70	200	60%	2.46	1	70	200	0	0%
006_02	June Creek	7	36	beaver pond	0%	6.15	1	40	200	0%	6.15	1	40	200	0	0%
006_02	June Creek	8	300	beaver pond	60%	2.46	2	600	1,000	60%	2.46	2	600	1,000	0	0%
006_02	June Creek	9	27	beaver pond	0%	6.15	2	50	300	0%	6.15	2	50	300	0	0%
006_02	June Creek	10	630	beaver pond	60%	2.46	2	1,000	2,000	60%	2.46	2	1,000	2,000	0	0%
006_02	June Creek	11	820	TNF #2606	43%	3.51	3	2,000	7,000	60%	2.46	3	2,000	5,000	(2,000)	0%
006_02	June Creek	12	490	TNF #2606	43%	3.51	3	1,000	4,000	70%	1.85	3	1,000	2,000	(2,000)	0%
006_02	June Creek	13	820	TNF #2606	43%	3.51	3	2,000	7,000	60%	2.46	3	2,000	5,000	(2,000)	0%
006_02	June Creek	14	200	TNF #2606	43%	3.51	3	600	2,000	40%	3.69	3	600	2,000	0	-3%
006_02	Trail Creek	1	630	aspen	100%	0.00	1	600	0	90%	0.62	1	600	400	400	-10%
006_02	Trail Creek	2	440	sage/grass	65%	2.15	1	400	900	30%	4.31	1	400	2,000	1,000	-35%
006_02	Trail Creek	3	77	aspen	100%	0.00	1	80	0	80%	1.23	1	80	100	100	-20%
006_02	Trail Creek	4	530	TNF #2606	88%	0.74	1	500	400	30%	4.31	1	500	2,000	2,000	-58%
006_02	Trail Creek	5	170	TNF #2606	58%	2.58	2	300	800	40%	3.69	2	300	1,000	200	-18%
006_02	Trail Creek	6	400	TNF #2606	58%	2.58	2	800	2,000	60%	2.46	2	800	2,000	0	0%
006_02	Trail Creek	7	80	TNF #2606	58%	2.58	2	200	500	30%	4.31	2	200	900	400	-28%
006_02	Trail Creek	8	550	TNF #1315	78%	1.35	2	1,000	1,000	90%	0.62	2	1,000	600	(400)	0%
006_02	Trail Creek	9	28	TNF #2606	58%	2.58	2	60	200	0%	6.15	2	60	400	200	-58%
006_02	Trail Creek	10	590	TNF #2606	58%	2.58	2	1,000	3,000	60%	2.46	2	1,000	2,000	(1,000)	0%
006_02	1st to Trail	1	210	TNF #2606	88%	0.74	1	200	100	70%	1.85	1	200	400	300	-18%
006_02	1st to Trail	2	37	TNF #2606	88%	0.74	1	40	30	30%	4.31	1	40	200	200	-58%
006_02	1st to Trail	3	540	TNF #1315	80%	1.23	1	500	600	90%	0.62	1	500	300	(300)	0%
006_02	1st to Trail	4	40	TNF #2606	88%	0.74	1	40	30	30%	4.31	1	40	200	200	-58%
006_02	1st to June	1	670	sage/grass	65%	2.15	1	700	2,000	40%	3.69	1	700	3,000	1,000	-25%
006_02	1st to June	2	370	aspen	100%	0.00	1	400	0	90%	0.62	1	400	200	200	-10%
006_02	1st to June	3	160	TNF #2606	88%	0.74	1	200	100	40%	3.69	1	200	700	600	-48%
006_02	Bates Creek	1	1100	TNF #1315	80%	1.23	1	1,000	1,000	90%	0.62	1	1,000	600	(400)	0%
006_02	Bates Creek	2	450	TNF #2606	88%	0.74	1	500	400	60%	2.46	1	500	1,000	600	-28%
006_02	Bates Creek	3	640	TNF #2606	58%	2.58	2	1,000	3,000	70%	1.85	2	1,000	2,000	(1,000)	0%
006_02	Bates Creek	4	380	TNF #2606	58%	2.58	2	800	2,000	60%	2.46	2	800	2,000	0	0%
006_02	Bates Creek	5	200	TNF #2606	58%	2.58	2	400	1,000	50%	3.08	2	400	1,000	0	-8%
006_02	Gibson Creek	1	1300	TNF #1315	80%	1.23	1	1,000	1,000	90%	0.62	1	1,000	600	(400)	0%
006_02	Gibson Creek	2	640	TNF #2606	88%	0.74	1	600	400	70%	1.85	1	600	1,000	600	-18%
006_02	Gibson Creek	3	880	TNF #1315	78%	1.35	2	2,000	3,000	80%	1.23	2	2,000	2,000	(1,000)	0%
006_02	Gibson Creek	4	520	TNF #2606	58%	2.58	2	1,000	3,000	70%	1.85	2	1,000	2,000	(1,000)	0%
006_02	Gibson Creek	5	360	TNF #2606	43%	3.51	3	1,000	4,000	70%	1.85	3	1,000	2,000	(2,000)	0%
006_02	Gibson Creek	6	330	TNF #2606	43%	3.51	3	1,000	4,000	50%	3.08	3	1,000	3,000	(1,000)	0%
006_02	Gibson Creek	7	130	TNF #2606	43%	3.51	3	400	1,000	70%	1.85	3	400	700	(300)	0%

Table 15 (cont.). Existing and target solar loads for the 2nd-order assessment unit of Fall Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
006_02	1st to Gibson	1	2370	TNF #1315	80%	1.23	1	2,000	2,000	80%	1.23	1	2,000	2,000	0	0%
006_02	1st to Gibson	2	1100	TNF #1315	80%	1.23	1	1,000	1,000	90%	0.62	1	1,000	600	(400)	0%
006_02	Blacktail Canyon	1	720	TNF #1315	80%	1.23	1	700	900	90%	0.62	1	700	400	(500)	0%
006_02	Blacktail Canyon	2	230	TNF #2606	88%	0.74	1	200	100	60%	2.46	1	200	500	400	-28%
006_02	Blacktail Canyon	3	1100	TNF #2606	88%	0.74	1	1,000	700	80%	1.23	1	1,000	1,000	300	-8%
006_02	Blacktail Canyon	4	310	TNF #2606	88%	0.74	1	300	200	90%	0.62	1	300	200	0	0%
006_02	Blacktail Canyon	5	440	TNF #2606	58%	2.58	2	900	2,000	60%	2.46	2	900	2,000	0	0%
006_02	Blacktail Canyon	6	210	TNF #2606	58%	2.58	2	400	1,000	90%	0.62	2	400	200	(800)	0%
006_02	Blacktail Canyon	7	720	TNF #2606	58%	2.58	2	1,000	3,000	50%	3.08	2	1,000	3,000	0	-8%
006_02	Sawmill Creek	1	1700	TNF #1315	80%	1.23	1	2,000	2,000	90%	0.62	1	2,000	1,000	(1,000)	0%
006_02	12th to Fall	1	1600	TNF #1315	80%	1.23	1	2,000	2,000	90%	0.62	1	2,000	1,000	(1,000)	0%
006_02	Rash Canyon	1	1600	TNF #1315	80%	1.23	1	2,000	2,000	80%	1.23	1	2,000	2,000	0	0%
006_02	Rash Canyon	2	130	TNF #1315	80%	1.23	1	100	100	50%	3.08	1	100	300	200	-30%
006_02	Rash Canyon	3	2000	TNF #1315	78%	1.35	2	4,000	5,000	80%	1.23	2	4,000	5,000	0	0%
006_02	Rash Canyon	4	280	TNF #1315	67%	2.03	3	800	2,000	50%	3.08	3	800	2,000	0	-17%
006_02	Rash Canyon	5	480	TNF #1315	67%	2.03	3	1,000	2,000	90%	0.62	3	1,000	600	(1,000)	0%
006_02	Rash Canyon	6	330	TNF #1315	67%	2.03	3	1,000	2,000	70%	1.85	3	1,000	2,000	0	0%
006_02	Rash Canyon	7	310	TNF #2606	43%	3.51	3	900	3,000	50%	3.08	3	900	3,000	0	0%
006_02	13th to Fall	1	370	TNF #2606	88%	0.74	1	400	300	50%	3.08	1	400	1,000	700	-38%
006_02	13th to Fall	2	1100	TNF #1315	80%	1.23	1	1,000	1,000	80%	1.23	1	1,000	1,000	0	0%
006_02	13th to Fall	3	450	sage/grass	39%	3.75	2	900	3,000	30%	4.31	2	900	4,000	1,000	-9%
006_02	Porcupine Creek	1	1700	TNF #1315	80%	1.23	1	2,000	2,000	70%	1.85	1	2,000	4,000	2,000	-10%
006_02	Porcupine Creek	2	1900	TNF #2606	58%	2.58	2	4,000	10,000	70%	1.85	2	4,000	7,000	(3,000)	0%
							Totals		330,000					270,000	0	

Table 17. Existing and target solar loads for the 4th-order assessment unit of Rainey Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
028_04	Rainey Creek	1	400	Geyer willow	35%	4.00	7	3,000	10,000	50%	3.08	7	3,000	9,000	(1,000)	0%
028_04	Rainey Creek	2	1800	Geyer willow	35%	4.00	7	10,000	40,000	40%	3.69	7	10,000	40,000	0	0%
028_04	Rainey Creek	3	720	Geyer willow	35%	4.00	7	5,000	20,000	50%	3.08	7	5,000	20,000	0	0%
028_04	Rainey Creek	4	400	Geyer willow	35%	4.00	7	3,000	10,000	30%	4.31	7	3,000	10,000	0	-5%
028_04	Rainey Creek	5	460	Geyer willow	35%	4.00	7	3,000	10,000	40%	3.69	7	3,000	10,000	0	0%
028_04	Rainey Creek	6	1520	Geyer willow	35%	4.00	7	10,000	40,000	30%	4.31	7	10,000	40,000	0	-5%
028_04	Rainey Creek	7	270	Geyer willow	31%	4.24	8	2,000	8,000	30%	4.31	8	2,000	9,000	1,000	-1%
028_04	Rainey Creek	8	930	narrowleaf	75%	1.54	8	7,000	10,000	20%	4.92	8	7,000	30,000	20,000	-55%
028_04	Rainey Creek	9	300	narrowleaf	75%	1.54	8	2,000	3,000	10%	5.54	8	2,000	10,000	7,000	-65%
028_04	Rainey Creek	10	550	narrowleaf	75%	1.54	8	4,000	6,000	30%	4.31	8	4,000	20,000	10,000	-45%
028_04	Rainey Creek	11	230	narrowleaf	75%	1.54	8	2,000	3,000	50%	3.08	8	2,000	6,000	3,000	-25%
028_04	Rainey Creek	12	800	narrowleaf	75%	1.54	8	6,000	9,000	40%	3.69	8	6,000	20,000	10,000	-35%
028_04	Rainey Creek	13	1300	narrowleaf	75%	1.54	8	10,000	20,000	20%	4.92	8	10,000	50,000	30,000	-55%
028_04	Rainey Creek	14	1100	Geyer willow	31%	4.24	8	9,000	40,000	0%	6.15	8	9,000	60,000	20,000	-31%
028_04	Rainey Creek	15	210	Geyer willow	31%	4.24	8	2,000	8,000	10%	5.54	8	2,000	10,000	2,000	-21%
028_04	Rainey Creek	16	1300	Geyer willow	29%	4.37	9	10,000	40,000	0%	6.15	9	10,000	60,000	20,000	-29%
028_04	Rainey Creek	17	100	Geyer willow	29%	4.37	9	900	4,000	10%	5.54	9	900	5,000	1,000	-19%
028_04	Rainey Creek	18	200	Geyer willow	29%	4.37	9	2,000	9,000	0%	6.15	9	2,000	10,000	1,000	-29%
028_04	Rainey Creek	19	19	Geyer willow	29%	4.37	9	200	900	90%	0.62	9	200	100	(800)	0%
028_04	Rainey Creek	20	500	Geyer willow	29%	4.37	9	5,000	20,000	0%	6.15	9	5,000	30,000	10,000	-29%
028_04	Rainey Creek	21	48	Geyer willow	29%	4.37	9	400	2,000	40%	3.69	9	400	1,000	(1,000)	0%
028_04	Rainey Creek	22	710	Geyer willow	29%	4.37	9	6,000	30,000	0%	6.15	9	6,000	40,000	10,000	-29%
028_04	Rainey Creek	23	14	Geyer willow	29%	4.37	9	100	400	90%	0.62	9	100	60	(300)	0%
028_04	Rainey Creek	24	320	Geyer willow	29%	4.37	9	3,000	10,000	0%	6.15	9	3,000	20,000	10,000	-29%
028_04	Rainey Creek	25	83	Geyer willow	29%	4.37	9	700	3,000	10%	5.54	9	700	4,000	1,000	-19%
028_04	Rainey Creek	26	450	Geyer willow	29%	4.37	9	4,000	20,000	0%	6.15	9	4,000	20,000	0	-29%
028_04	Rainey Creek	27	85	Geyer willow	29%	4.37	9	800	3,000	30%	4.31	9	800	3,000	0	0%
028_04	Rainey Creek	28	190	Geyer willow	29%	4.37	9	2,000	9,000	0%	6.15	9	2,000	10,000	1,000	-29%
028_04	Rainey Creek	29	18	Geyer willow	29%	4.37	9	200	900	90%	0.62	9	200	100	(800)	0%
028_04	Rainey Creek	30	860	Geyer willow	29%	4.37	9	8,000	30,000	0%	6.15	9	8,000	50,000	20,000	-29%
028_04	Rainey Creek	31	20	Geyer willow	29%	4.37	9	200	900	90%	0.62	9	200	100	(800)	0%
028_04	Rainey Creek	32	1100	Geyer willow	26%	4.55	10	11,000	50,000	0%	6.15	10	11,000	68,000	18,000	-26%
028_04	Rainey Creek	33	680	Geyer willow	26%	4.55	10	6,800	31,000	10%	5.54	10	6,800	38,000	7,000	-16%
028_04	Rainey Creek	34	58	Geyer willow	26%	4.55	10	580	2,600	0%	6.15	10	580	3,600	1,000	-26%
028_04	Rainey Creek	35	11	Geyer willow	26%	4.55	10	110	500	90%	0.62	10	110	68	(430)	0%
028_04	Rainey Creek	36	45	Geyer willow	26%	4.55	10	450	2,000	0%	6.15	10	450	2,800	800	-26%
028_04	Rainey Creek	37	450	Geyer willow	26%	4.55	10	4,500	20,000	10%	5.54	10	4,500	25,000	5,000	-16%
028_04	Rainey Creek	38	870	Geyer willow	26%	4.55	10	8,700	40,000	20%	4.92	10	8,700	43,000	3,000	-6%
							Totals		570,000					780,000	210,000	

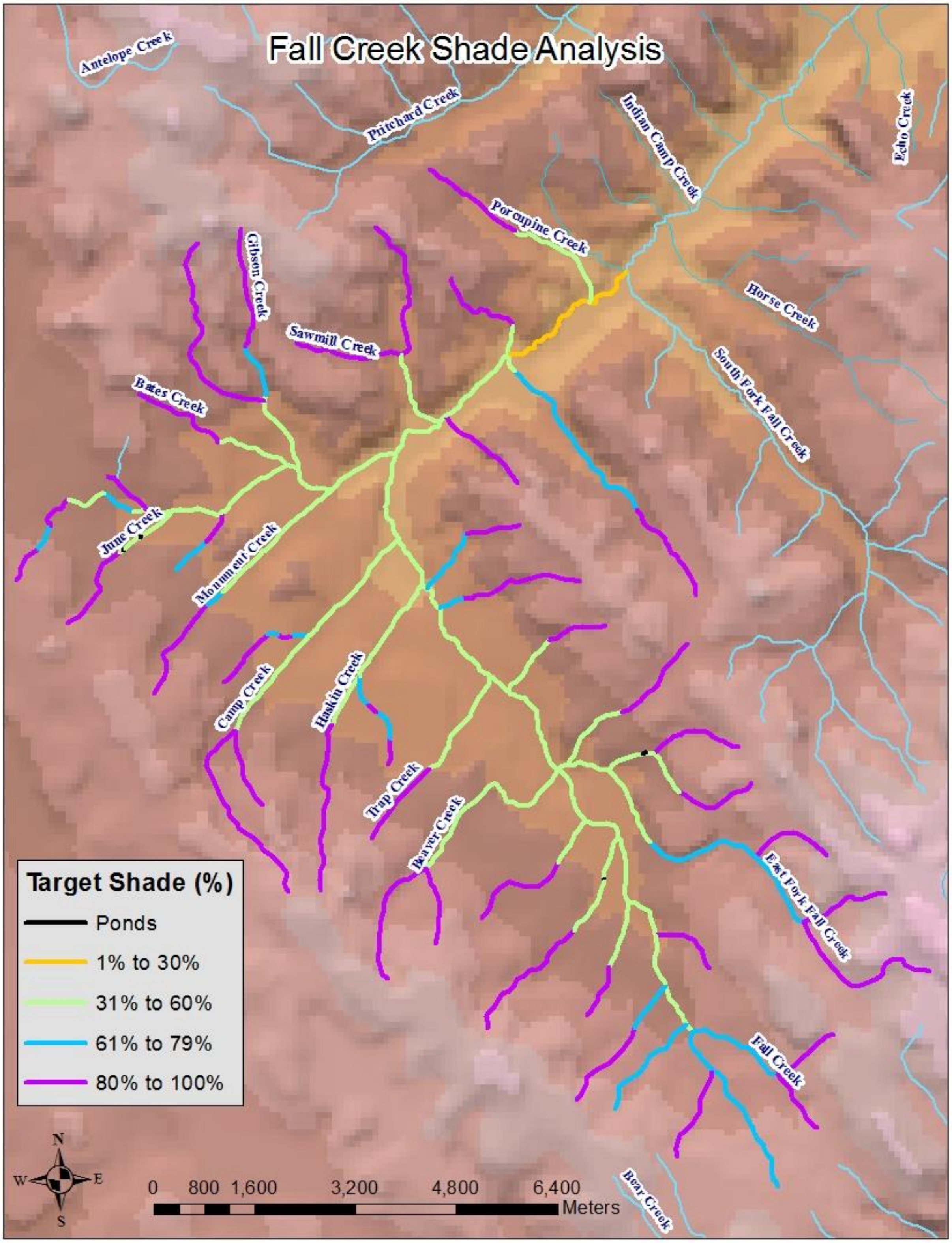

Figure 20. Target shade for Fall Creek.

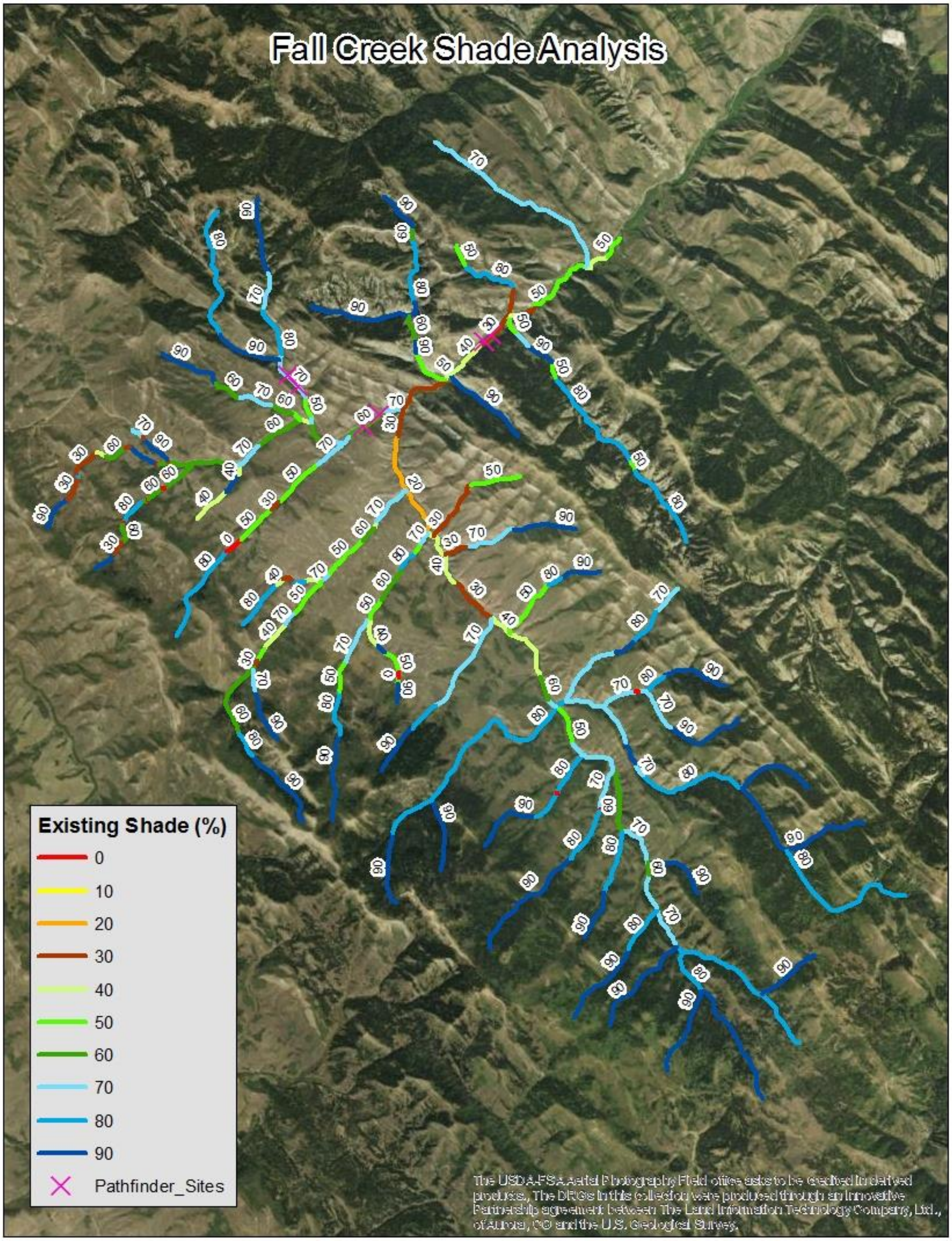

Figure 21. Existing shade estimated for Fall Creek by aerial photo interpretation.

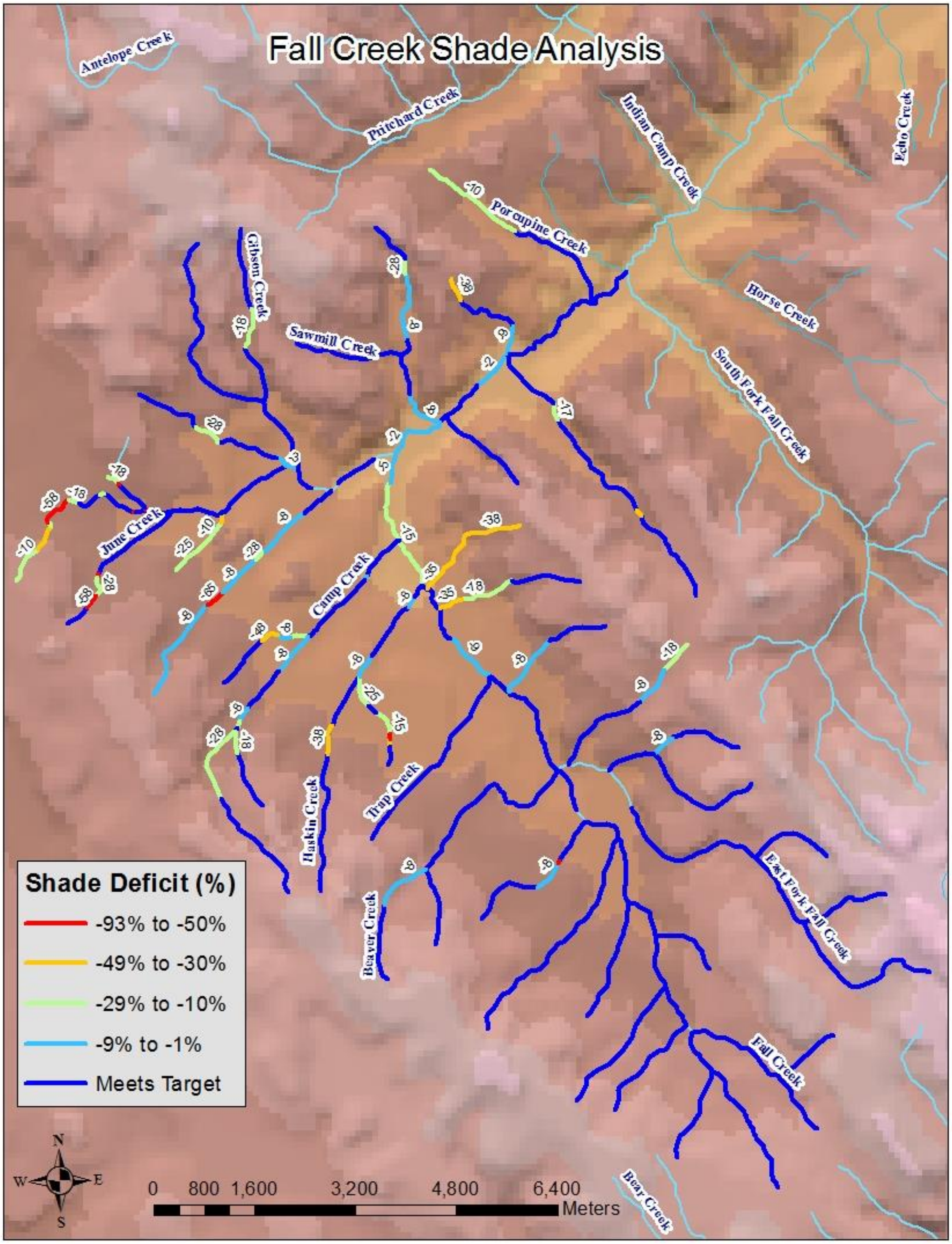

Figure 22. Shade deficit (difference between existing and target) for Fall Creek.

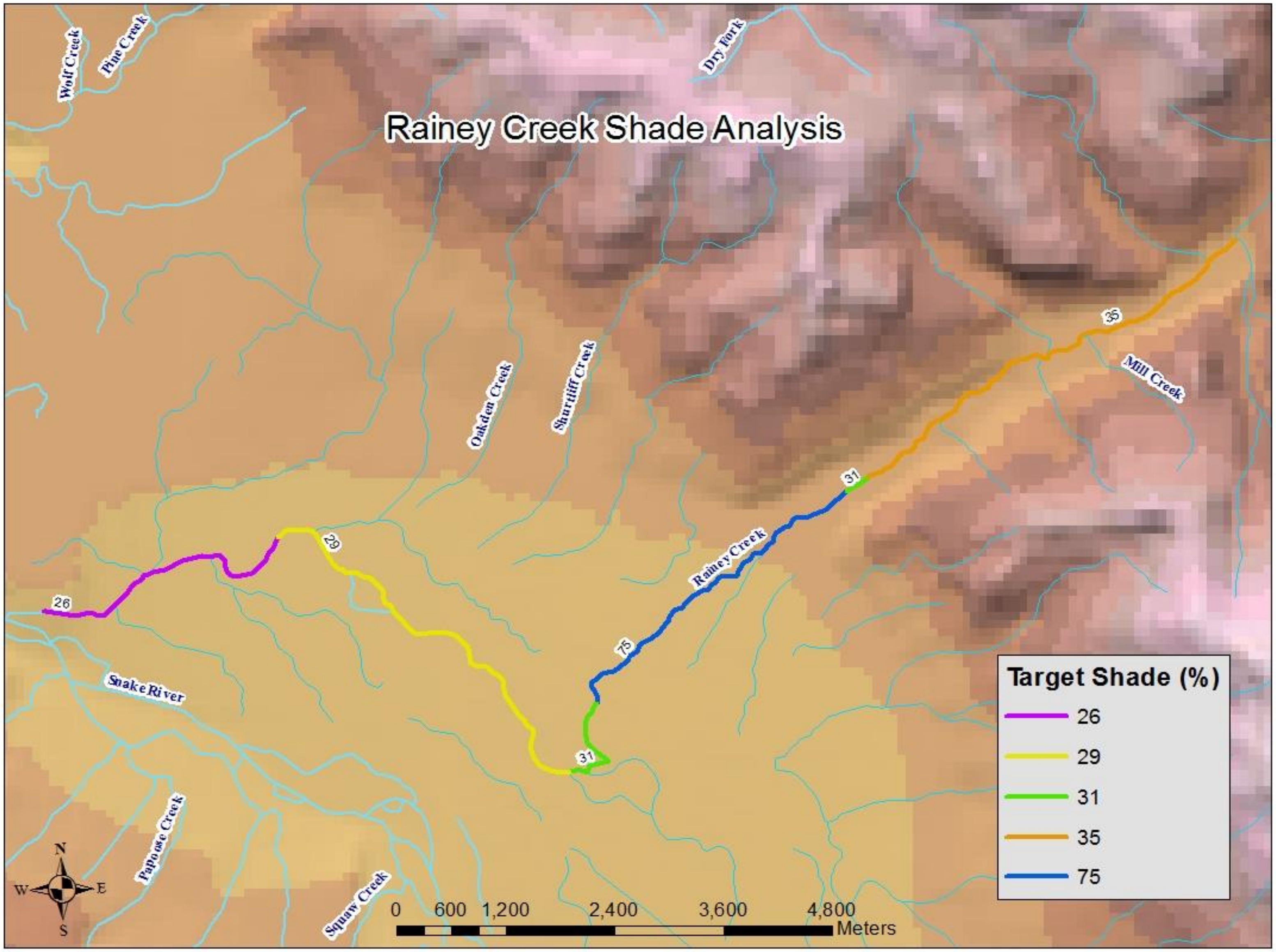

Figure 23. Target shade for Rainey Creek.

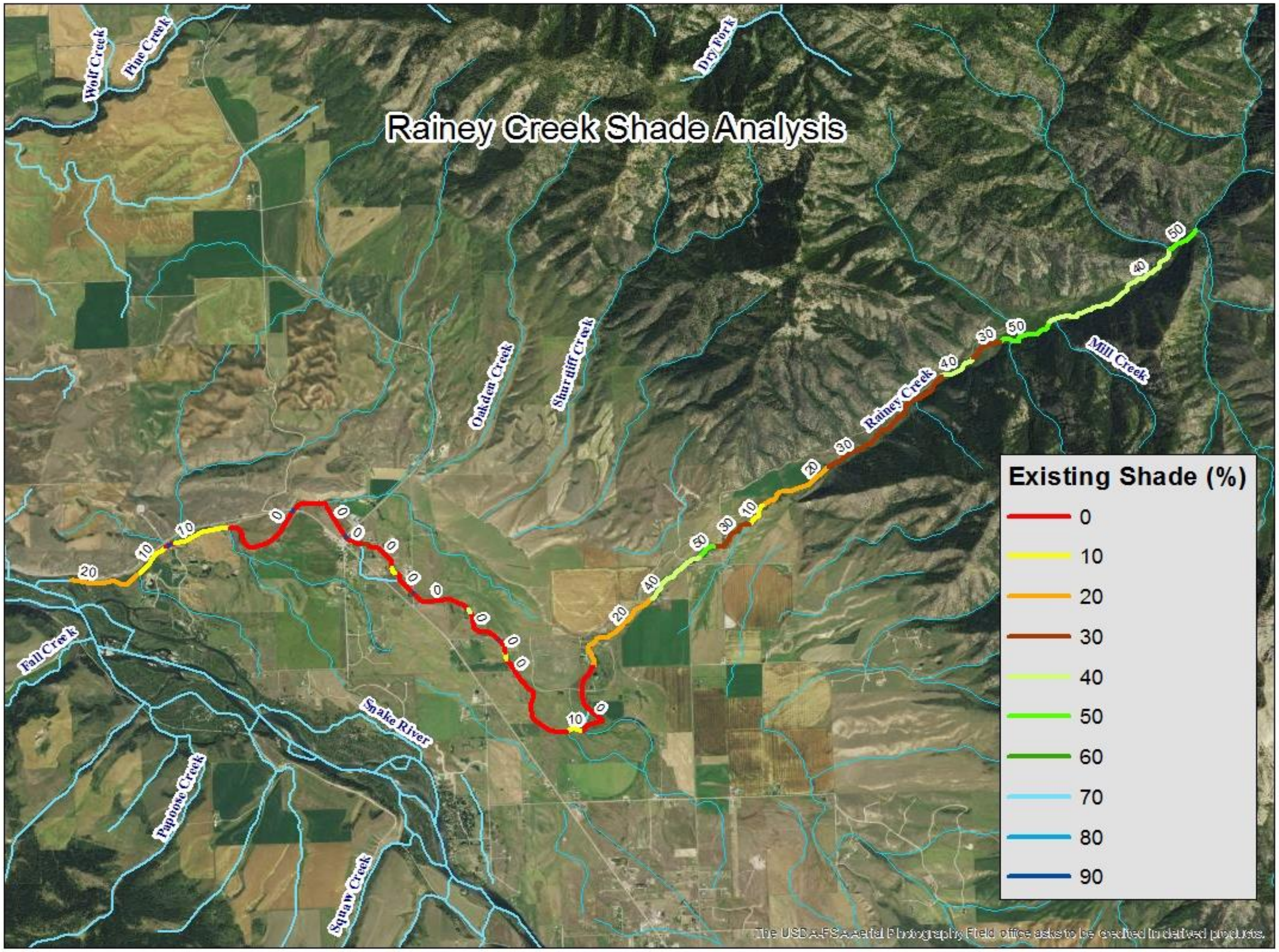

Figure 24. Existing shade estimated for Rainey Creek by aerial photo interpretation.

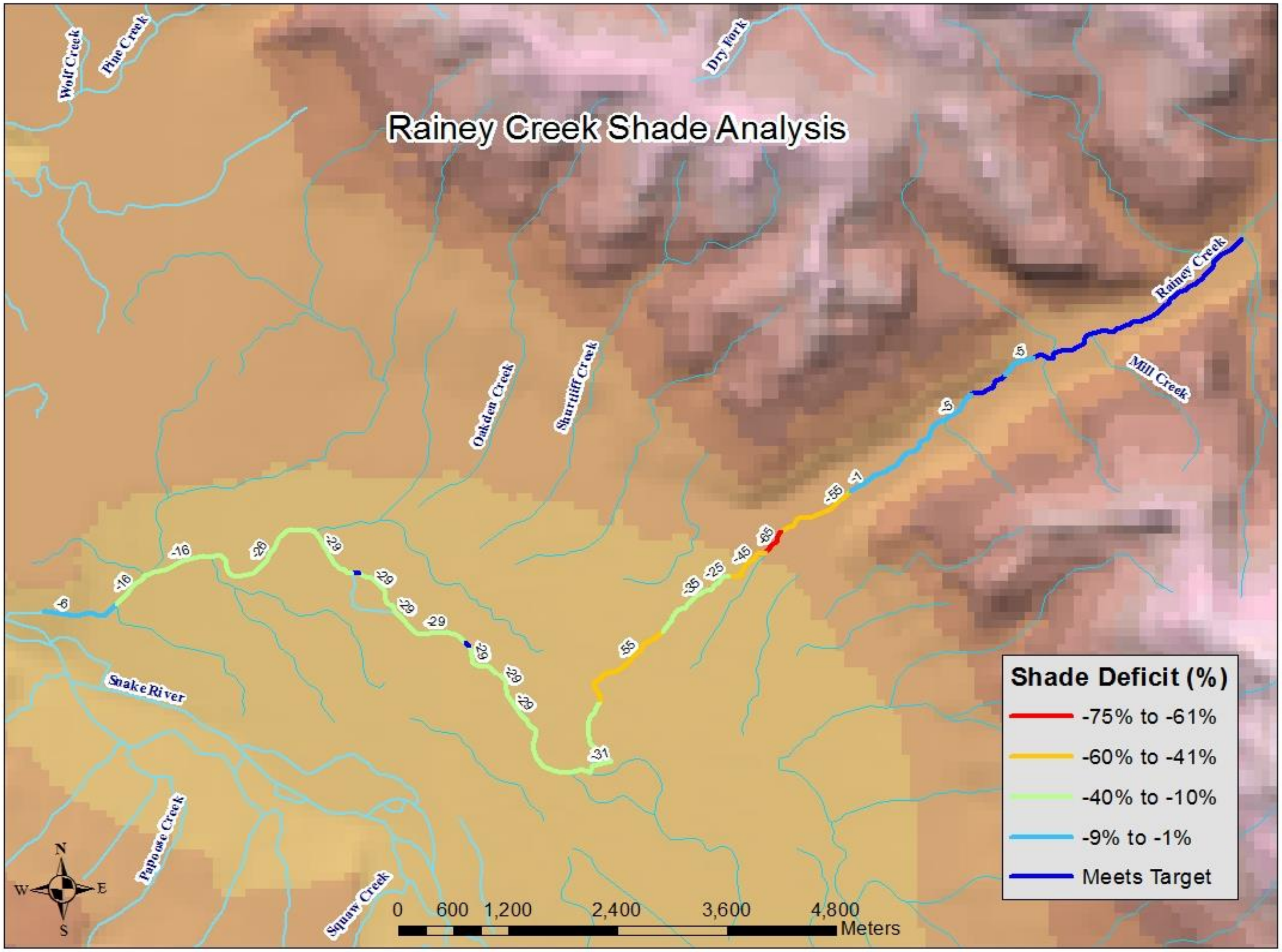

Figure 25. Shade deficit (difference between existing and target) for Rainey Creek.

5.4 Load Allocation

Because this TMDL is based on PNV, which is equivalent to background loading, the load allocation is essentially the desire to achieve background conditions. However, in order to reach that objective, load allocations are assigned to nonpoint source activities that have affected or may affect riparian vegetation and shade as a whole. Therefore, load allocations are stream segment specific and dependent on the target load for a given segment. Table 14–Table 17 show the target shade and corresponding target summer load. This target load (i.e., load capacity) is necessary to achieve background conditions. There is no opportunity to further remove shade from the stream by any activity without exceeding its load capacity. Additionally, because this TMDL is dependent on background conditions for achieving water quality standards, all tributaries to the waters examined here need to be in natural conditions to prevent excess heat loads to the system.

Table 18 shows the total existing, target, and excess loads and the average lack of shade for each water body examined. The size of a stream influences the size of the excess load. Large streams have higher existing and target loads by virtue of their larger channel widths. However, 2nd-order AUs tend to be conglomerations of many individual 1st- and 2nd-order streams, making the total loads large as well.

Although this TMDL analysis focuses on total solar loads, it is important to note that differences between existing and target shade, as depicted in the shade deficit figures (Figure 22 and Figure 25), are the key to successfully restoring these waters to achieve water quality standards. Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should focus on the largest differences between existing and target shade as locations to prioritize implementation efforts. Each load analysis table contains a column that lists the lack of shade on the stream segment. This value is derived from subtracting target shade from existing shade for each segment. Thus, stream segments with the largest lack of shade are in the worst shape. The average lack of shade derived from the last column in each load analysis table is listed in Table 18 and provides a general level of comparison among streams.

Table 18. Total solar loads and average lack of shade for all waters.

Water Body and Assessment Unit	Total Existing Load	Total Target Load	Excess Load (Necessary % Reduction)	Average Shade Deficit (%)
		(kWh/day)		
Fall Creek, 1st and 2nd order ID17040104SK006_02	270,000	330,000	0 (0%)	-10
Fall Creek, 3rd order ID17040104SK006_03	60,000	94,000	0 (0%)	0
Fall Creek, 4th order ID17040104SK006_04	310,000	350,000	0 (0%)	-2
Rainey Creek, 4th order ID17040104SK028_04	780,000	570,000	210,000 (27%)	-19

Note: Load data are rounded to two significant figures, which may present rounding errors.

Fall Creek from its headwaters through the 4th order has abundant shade and no excess load. Willow communities are extensive and are often flooded by beaver activity. The 4th order of Rainey Creek, on the other hand, lacks considerable shade as it enters the alluvial fan formerly vegetated by narrowleaf cottonwood. Bottomlands are now pasture lands and most willows have likely been removed to enhance grazing opportunities.

A certain amount of excess load is potentially created by the existing shade/target shade difference inherent in the load analysis. Because existing shade is reported as a 10% shade class and target shade a unique integer between 0% and 100%, a difference usually exists between the two. One example would be a particular stream segment that has a target shade of 86% based on its vegetation type and natural bankfull width. If existing shade on that segment were at target level, it would be recorded as 80% in the load analysis because it falls into the 80% existing shade class. There is an automatic difference of 6%, which could be attributed to the margin of safety.

5.4.1 Water Diversion

Stream temperature may be affected by diversions of water for water rights purposes. Flow diversion reduces the amount of water exposed to a given level of solar radiation in the stream channel, which can result in increased water temperature in that channel. Loss of flow in the channel also affects the ability of the near-stream environment to support shade-producing vegetation, resulting in an increase in solar load to the channel.

Although these water temperature effects may occur, nothing in this TMDL supersedes any water appropriation in the affected watershed. Section 101(g), the Wallop Amendment, was added to the CWA as part of the 1977 amendments to address water rights. It reads as follows:

> It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this chapter. It is the further policy of Congress that nothing in this chapter shall be construed to supersede or abrogate rights to quantities of water which have been established by any State. Federal agencies shall co-operate with State and local agencies to develop comprehensive solutions to prevent, reduce and eliminate pollution in concert with programs for managing water resources.

Additionally, Idaho water quality standards indicate the following:

> The adoption of water quality standards and the enforcement of such standards is not intended to…interfere with the rights of Idaho appropriators, either now or in the future, in the utilization of the water appropriations which have been granted to them under the statutory procedure… (IDAPA 58.01.02.050.01)

In this TMDL, the impact diversions may be having on stream temperature was not measured. Water diversions are allowed for in state statute, and it is possible for a water body to be 100% allocated. The Palisades subbasin contains 1,374 surface water rights (1,692 including ground water rights). Figure 26 shows the locations of these points of diversion.

Diversions notwithstanding, reaching shade targets as discussed in the TMDL will protect remaining water in the channel and allow the stream to meet water quality standards for temperature. This TMDL will lead to cooler water by achieving shade that would be expected under natural conditions and water temperatures resulting from that shade. DEQ encourages local landowners and holders of water rights to voluntarily do whatever they can to help instream flow for the purpose of keeping channel water cooler for aquatic life.

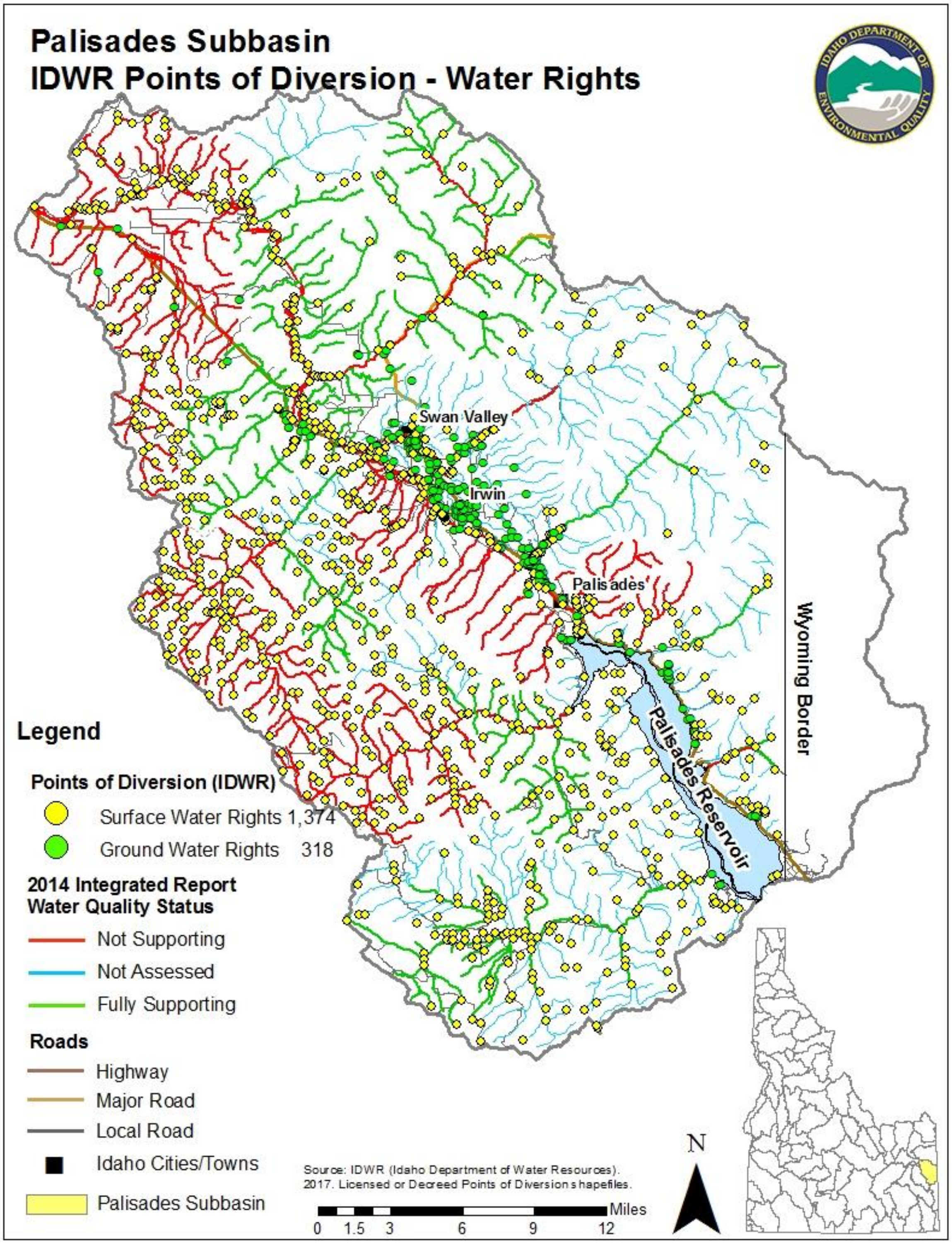

Figure 26. Palisades subbasin water diversions (IDWR 2018).

5.4.2 Margin of Safety

The margin of safety in this temperature TMDL is considered implicit in the design. Because the target is essentially background conditions, loads (shade levels) are allocated to lands adjacent to these streams at natural background levels. Because shade levels are established at natural background or system potential levels, it is unrealistic to set shade targets at higher, more conservative levels. Additionally, existing shade levels are reduced to the next lower 10% shade class, which on average underestimates actual shade in the load analysis. Although the load analysis used in this TMDL involves gross estimations that are likely to have large variances, load allocations are applied to the stream and its riparian vegetation rather than specific nonpoint source activities and can be adjusted as more information is gathered from the stream environment.

5.4.3 Seasonal Variation

This temperature TMDL is based on average spring-summer loads. All loads have been calculated to be inclusive of the 6-month period from April through September. This time period is when the combination of increasing air and water temperatures coincide with increasing solar inputs and vegetative shade. The critical time periods are April through June when spring salmonid spawning occurs, July and August when maximum temperatures may exceed cold water aquatic life criteria, and September when fall salmonid spawning is most likely to be affected by higher temperatures. Water temperature is not likely to be a problem for beneficial uses outside of this time period because of cooler weather and lower sun angle.

5.4.4 Reasonable Assurance

CWA §319 requires each state to develop and submit a nonpoint source management plan. The *Idaho Nonpoint Source Management Plan* was approved by EPA in March 2015 (DEQ 2015b). The plan identifies programs to achieve implementation of nonpoint source BMPs, includes a schedule for program milestones, outlines key agencies and agency roles, is certified by the state attorney general to ensure that adequate authorities exist to implement the plan, and identifies available funding sources.

Idaho’s nonpoint source management program describes many of the voluntary and regulatory approaches the state will take to abate nonpoint pollution sources. One of the prominent programs described in the plan is the provision for public involvement, including BAGs and watershed advisory groups (WAGs).

The Idaho water quality standards refer to existing authorities to control nonpoint pollution sources in Idaho. Some of these authorities and responsible agencies are listed in Table 19.

Table 19. State of Idaho's regulatory authority for nonpoint pollution sources.

Authority	Water Quality Standard	Responsible Agency
Rules Pertaining to the Idaho Forest Practices Act (IDAPA 20.02.01)	58.01.02.350.03(a)	Idaho Department of Lands
Solid Waste Management Rules and Standards (IDAPA 58.01.06)	58.01.02.350.03(b)	Idaho Department of Environmental Quality
Individual/Subsurface Sewage Disposal Rules (IDAPA 58.01.03)	58.01.02.350.03(c)	Idaho Department of Environmental Quality
Stream Channel Alteration Rules (IDAPA 37.03.07)	58.01.02.350.03(d)	Idaho Department of Water Resources
Rules Governing Exploration, Surface Mining and Closure of Cyanidation Facilities (IDAPA 20.03.02)	58.01.02.350.03(f)	Idaho Department of Lands
Dredge and Placer Mining Operations in Idaho (IDAPA 20.03.01)	58.01.02.350.03(g)	Idaho Department of Lands
Rules Governing Dairy Waste (IDAPA 02.04.14)	58.01.02.350.03(h)	Idaho State Department of Agriculture

Idaho uses a voluntary approach to address agricultural nonpoint sources; however, regulatory authority is found in the water quality standards (IDAPA 58.01.02.350.01–03).

IDAPA 58.01.02.055.07 refers to the *Idaho Agricultural Pollution Abatement Plan* (Ag Plan) (ISWCC 2015), which provides direction to the agricultural community regarding approved BMPs. A portion of the Ag Plan outlines responsible agencies or elected groups (soil conservation districts) that will take the lead if nonpoint source pollution problems need to be addressed. For agricultural activity, the Ag Plan assigns the local soil conservation districts to assist the landowner/operator with developing and implementing BMPs to abate nonpoint source pollution associated with the land use. If a voluntary approach does not succeed in abating the pollutant problem, the state may seek injunctive relief for those situations determined to be an imminent and substantial danger to public health or the environment (IDAPA 58.01.02.350.02.a).

The Idaho water quality standards specify that if water quality monitoring indicates water quality standards are not being met, even with the use of BMPs or knowledgeable and reasonable practices, the state may request that the designated agency evaluate and/or modify the BMPs to protect beneficial uses. If necessary, the state may seek injunctive or other judicial relief against the operator of a nonpoint source activity in accordance with the DEQ director's authority provided in Idaho Code §39-108 (IDAPA 58.01.02.350). The water quality standards list designated agencies responsible for reviewing and revising nonpoint source BMPs (section 5.5.3).

5.4.5 Construction Stormwater and TMDL Wasteload Allocations

No known National Pollutant Discharge Elimination System (NPDES) permitted point sources exist in the affected watersheds and thus no wasteload allocations. A number of restoration projects were implemented in the Palisades subbasin. Some included activities on the streambanks of Rainey Creek (see Section 4.2 for individual projects). The majority of these projects did not disturb 1 or more acres and did not qualify for Construction General Permit (CGP) coverage. Any projects which did disturb 1 or more acres obtained the appropriate permits, including: Nationwide 404 permits, 401 certifications, and Stream Channel Alteration permits.

Should a point source be proposed that would have thermal consequences on these waters, background provisions in Idaho water quality standards addressing such discharges (IDAPA 58.01.02.200.09; IDAPA 58.01.02.401.01) should be applied (Appendix B).

Stormwater runoff is water from rain or snowmelt that does not immediately infiltrate into the ground and flows over or through natural or man-made storage or conveyance systems. When undeveloped areas are converted to land uses with impervious surfaces—such as buildings, parking lots, and roads—the natural hydrology of the land is altered and can result in increased surface runoff rates, volumes, and pollutant loads. Certain types of stormwater runoff are considered point source discharges for CWA purposes, including stormwater that is associated with municipal separate storm sewer systems (MS4s), industrial stormwater covered under the Multi-Sector General Permit (MSGP), and construction stormwater covered under the Construction General Permit (CGP). For more information about these permits and managing stormwater, see Appendix D.

5.4.6 Reserve for Growth

Given the nature of the pollutant and landscape, no growth reserve has been included in this TMDL. The load capacity has been allocated to the existing sources in the watershed. Any new sources will need to obtain an allocation from the existing load allocation and would be addressed in a future TMDL revision.

5.5 Implementation Strategies

Implementation strategies for TMDLs produced using PNV-based shade and solar loads should incorporate the load analysis tables presented in this TMDL (Table 14–Table 17). These tables need to be updated, first to field verify the remaining existing shade levels and second to monitor progress toward achieving reductions and TMDL goals. Using the Solar Pathfinder to measure existing shade levels in the field is important to achieving both objectives. Further field verification will likely find discrepancies with reported existing shade levels in the load analysis tables. Due to the inexact nature of the aerial photo interpretation technique, these tables should not be viewed as complete until verified. Implementation strategies should include Solar Pathfinder monitoring to simultaneously field verify the TMDL and mark progress toward achieving desired load reductions.

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that TMDL goals are not being met or significant progress is not being made toward achieving the goals. Reasonable assurance (addressed in section 5.4.4) for the TMDL to meet water quality standards is based on the implementation strategy. There may be a variety of reasons that individual stream segments do not meet shade targets, including natural phenomena (e.g., beaver ponds, springs, wet meadows, and past natural disturbances) and/or historic land-use activities (e.g., logging, grazing, and mining). It is important that existing shade for each stream segment be field verified to determine if shade differences are real and result from activities that are controllable. Information within this TMDL (maps and load analysis tables) should be used to guide and prioritize implementation investigations. The information in this TMDL may need further adjustment to reflect new information and conditions in the future.

5.5.1 Time Frame

Implementing the temperature TMDL relies on riparian area management practices that will provide a mature canopy cover to shade the stream and prevent excess solar loading. Because implementation is dependent on mature riparian communities to substantially improve stream temperatures, DEQ believes 10–20 years may be a reasonable amount time for achieving water quality standards. Shade targets will not be achieved all at once. Given their smaller bankfull widths, smaller streams may reach targets sooner than larger streams.

DEQ continues to re-evaluate TMDLs on a 5-year cycle. During the 5-year review, implementation actions completed, in progress, and planned will be reviewed, and pollutant load allocations will be reassessed accordingly.

5.5.2 Approach

Water temperature affects all life in streams, and the existence and health of riparian communities directly affect water temperature. Degraded or denuded riparian systems can cause an increase in water temperature, therefore detrimentally affecting macroinvertebrate lifecycles and fish reproduction and survival. In contrast, robust riparian communities provide shade, prevent sedimentation, and stabilize streambanks, which foster vibrant stream health. Designated management agencies, citizens, and landowners are responsible for developing implementation plans, which include milestones and timelines, in order to maintain or restore stream health. They are also responsible for implementing appropriate BMPs to restore impaired waters and monitoring progress toward achieving water quality standards.

Funding provided under CWA §319 and other funds will be used to encourage voluntary projects to reduce nonpoint source pollution.

5.5.3 Responsible Parties

DEQ and the designated management agencies in Idaho have primary responsibility for overseeing implementation in cooperation with landowners and managers. In Idaho, these agencies, and their federal and state partners, are charged by the CWA to lend available technical assistance and other appropriate support to local efforts for water quality improvements. Designated state agencies are responsible for assisting with preparing specific implementation plans, particularly for those resources for which they have regulatory authority or programmatic responsibilities:

- Idaho Department of Lands for timber harvest, oil and gas exploration and development, and mining
- Idaho Soil and Water Conservation Commission for grazing and agricultural activities
- Idaho Transportation Department for public road construction
- Idaho State Department of Agriculture for aquaculture
- DEQ for all other activities

In addition to the designated management agencies, the public—through the WAG/BAG and other equivalent organizations or processes—will have opportunities to be involved in developing the implementation plan to the maximum extent practical. Public participation will significantly affect public acceptance of the document and the proposed control actions. Stakeholders (e.g., landowners, local governing authorities, taxpayers, industries, and land managers) are the most educated regarding the pollutant sources and will be called upon to help identify the most appropriate control actions for each area. Experience has shown that the best and most effective implementation plans are those developed with substantial public cooperation and involvement.

5.5.4 Implementation Monitoring Strategy

The objectives of a monitoring strategy are to demonstrate long-term recovery, better understand natural variability, track project and BMP implementation, and track the effectiveness of TMDL implementation. This monitoring and feedback mechanism is a major component of the reasonable assurance component of the TMDL implementation plan.

Monitoring will provide information on progress being made toward achieving TMDL allocations and water quality standards and will help in the interim evaluation of progress included in the development of 5-year reviews and future TMDLs.

The implementation plan will be tracked by accounting for the numbers, types, and locations of projects, BMPs, educational activities, or other actions taken to improve or protect water quality. Implementation plan monitoring will include watershed monitoring and BMP monitoring.

Effective shade monitoring can take place on any segment throughout the Rainey Creek AU (ID17040104SK028_04) and be compared to existing shade estimates seen in Figure 24 and described in Table 17. Those areas with the largest disparity between existing and target shade should be monitored with Solar Pathfinders to verify existing shade levels and determine progress toward meeting shade targets. Since many existing shade estimates have not been field verified, they may require adjustment during the implementation process. Stream segment length for each estimate of existing shade varies depending on the land use or landscape that has affected that shade level. It is appropriate to monitor within a given existing shade segment to see if that segment has increased its existing shade toward target levels. Ten equally spaced Solar Pathfinder measurements averaged together within that segment should suffice to determine new shade levels in the future.

5.5.5 Pollutant Trading

Pollutant trading (also known as water quality trading) is a contractual agreement to exchange pollution reductions between two parties. Pollutant trading is a business-like way of helping to solve water quality problems by focusing on cost-effective, local solutions to problems caused by pollutant discharges to surface waters. Pollutant trading is one of the tools available to meet reductions called for in a TMDL where point and nonpoint sources both exist in a watershed. For additional information, see Appendix E.

6 Conclusions

Overall, field data collected in 2017 from SEIs, bacteria sampling, and PNV shade monitoring indicated that the water quality in the Palisades subbasin is improving. SEIs conducted on 11 AUs, 9 of which have existing sediment TMDLs, revealed that the 80% streambank stability sediment target is being met. One of the AUs without a sediment TMDL that was listed in Category 5 as impaired for sediment (Snake River AU ID17040104SK008_02) met the 80% streambank stability sediment target. SEI results from the previous TMDL (DEQ 2015a) also indicated the streambanks met the 80% streambank stability sediment target. Therefore, it is recommended that this AU be delisted from Category 5 as impaired for sediment.

E. coli sampling on Rainey Creek (ID17040104SK028_04) determined it is meeting water quality standards, as the calculated geometric mean concentration is below the water quality criteria. Although the geometric mean calculated from all five required samples met the bacteria criterion, one of the samples exceeded the single sample criteria for secondary contact recreation. As a result, future sampling will be conducted to confirm that a bacteria impairment does not exist.

Effective shade targets were established for Rainey Creek (ID17040104SK028_04) and Fall Creek (ID17040104SK006_02, ID17040104SK006_03, and ID17040104SK006_04) based on the concept of shading under PNV resulting in natural background temperature levels. These targets were compared to existing shade determined from aerial photo interpretation for all four of the AUs and from Solar Pathfinder data for three of the AUs. Target and existing shade levels were compared to determine the amount of shade needed to bring water bodies into compliance with natural background provisions in Idaho’s water quality standards (IDAPA 58.01.02). Only Rainey Creek (ID17040104SK028_04) needs thermal load reductions.

A PNV temperature TMDL was developed for Rainey Creek (AU ID17040104SK028_04) and is presented in section 5 of this document. The Fall Creek AUs (ID17040104SK006_02, ID17040104SK006_03, and ID17040104SK006_04) were found to have abundant shade with no excess solar loads. The willow communities in this area are robust and appear to be frequently flooded by beaver activity.

The primary goals managers should strive for with future implementation plans are: (1) reducing sediment and *E. coli* from entering streams by limiting livestock points of access to the streams and (2) meeting target shade levels for individual stream segments. Managers should focus on the largest differences between existing and target shade as locations to prioritize implementation efforts.

Table 20 summarizes the assessment outcomes for waters listed in Category 4a and Category 5 of the 2014 Integrated Report (DEQ 2016a).

Table 20. Summary of assessment outcomes for assessment units evaluated.

Assessment Unit Name	Assessment Unit Number	Pollutants	New TMDL Completed	Recommended Changes to Next Integrated Report	Justification
Snake River—Black Canyon Creek to river mile 856	ID17040104SK001_02	Sedimentation/ siltation	No	Keep in Category 4a	AU is meeting TMDL target for sediment; however, additional beneficial use assessments are needed.
Antelope Creek—source to mouth	ID17040104SK002_02	Sedimentation/ siltation	No	Keep in Category 4a	AU is meeting TMDL target for sediment; however, additional beneficial use assessments are needed.
	ID17040104SK002_03	Sedimentation/ siltation	No	Keep in Category 4a	AU was not analyzed. Inaccessible—on private property.
Fall Creek—source to South Fork Fall Creek	ID17040104SK006_02 ID17040104SK006_03 ID17040104SK006_04	Sedimentation/ siltation	No	Keep in Category 4a	AUs are meeting TMDL target for sediment; however, additional beneficial use assessments are needed.
		Temperature	No	Keep in Category 4a	Shade monitoring completed based on PNV. No solar load reductions necessary; however, additional beneficial use assessments are needed.
Snake River—Palisades Reservoir Dam to Fall Creek	ID17040104SK008_02	Combined biota/habitat bioassessments	No	Keep in Category 5	Additional investigation is needed to determine ultimate cause.
		Sedimentation/ siltation	No	Delist from Category 5	Results from SEIs performed for this TMDL and the previous TMDL (DEQ 2015a) indicated AU is meeting sediment targets.
Bear Creek—North Fork Bear Creek to Palisades Reservoir	ID17040104SK011_04	Sedimentation/ siltation	No	Keep in Category 4a	AU is meeting TMDL target for sediment; however, additional beneficial use assessments are needed.
Bear Creek—source to North Fork Bear Creek	ID17040104SK013_02 ID17040104SK013_03	Sedimentation/ siltation	No	Keep in Category 4a	AUs are meeting TMDL target for sediment; however, additional beneficial use assessments are needed.
Indian Creek—Idaho/Wyoming border to Palisades Reservoir	ID17040104SK024_04	Sedimentation/ siltation	No	Keep in Category 4a	AU is meeting TMDL target for sediment; however, additional beneficial use assessments are needed.
Rainey Creek—source to mouth	ID17040104SK028_04	Combined biota/habitat bioassessments	Yes	Delist for combined biota/habitat bioassessments	Temperature replaces combined biota/habitat bioassessments as cause.
				Include in Category 4a for temperature	Temperature TMDL completed based on PNV. Excess solar load from lack of existing shade.
		Escherichia coli (E. coli)	No	Keep in Category 4a	*E. coli* sampling to continue through summer.
Pine Creek—source to mouth	ID17040104SK029_03	Cause unknown	No	Keep in Category 5	AU was not analyzed during this review. Investigation is needed to determine potential cause.

This document was circulated for public comment, however, no comments were received. A final document distribution list is included in Appendix G.

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GIS Coverages

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Glossary

§303(d)

Refers to section 303 subsection "d" of the Clean Water Act. Section 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to United States Environmental Protection Agency approval.

Assessment Unit (AU)

A group of similar streams that have similar land use practices, ownership, or land management. However, stream order is the main basis for determining AUs. All the waters of the state are defined using AUs, and because AUs are a subset of water body identification numbers, they tie directly to the water quality standards so that beneficial uses defined in the water quality standards are clearly tied to streams on the landscape.

Beneficial Use

Any of the various uses of water that are recognized in water quality standards, including, but not limited to, aquatic life, recreation, water supply, wildlife habitat, and aesthetics.

Beneficial Use Reconnaissance Program (BURP)

A program for conducting systematic biological and physical habitat surveys of water bodies in Idaho. BURP protocols address lakes, reservoirs, and wadeable streams and rivers.

Exceedance

A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.

Fully Supporting

In compliance with water quality standards and within the range of biological reference conditions for all designated and existing beneficial uses as determined through the *Water Body Assessment Guidance* (DEQ 2016b).

Load Allocation (LA)

A portion of a water body's load capacity for a given pollutant that is given to a particular nonpoint source (by class, type, or geographic area).

Load

The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Load is the product of flow (discharge) and concentration.

Load Capacity (LC)

How much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, a margin of safety, and natural background contributions, it becomes a total maximum daily load.

Margin of Safety (MOS)

An implicit or explicit portion of a water body's load capacity set aside to allow for uncertainly about the relationship between the pollutant loads and the quality of the receiving water body. The margin of safety is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The margin of safety is not allocated to any sources of pollution.

Nonpoint Source

A dispersed source of pollutants generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and nonirrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.

Not Assessed (NA)

A concept and an assessment category describing water bodies that have been studied but are missing critical information needed to complete an assessment.

Not Fully Supporting

Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the *Water Body Assessment Guidance* (DEQ 2016b).

Point Source

A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable “point” of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater plants.

Pollutant

Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.

Pollution

A very broad concept that encompasses human-caused changes in the environment that alter the functioning of natural processes and produce undesirable environmental and health effects. Pollution includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.

Potential Natural Vegetation (PNV)

A.U. Küchler (1964) defined potential natural vegetation as vegetation that would exist without human interference and if the resulting plant succession were projected to its climax condition while allowing for natural disturbance processes such as fire. Our use of the term reflects Küchler’s definition in that riparian vegetation at PNV would produce a system potential level of shade on streams and includes recognition of some level of natural disturbance.

Stream Order

Hierarchical ordering of streams based on the degree of branching. A 1st-order stream is an unforked or unbranched stream. Under Strahler’s (1957) system, higher-order streams result from the joining of two streams of the same order.

Total Maximum Daily Load (TMDL)

A TMDL is a water body’s load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual basis. A TMDL is equal to the load capacity, such that load capacity = margin of safety + natural background + load allocation + wasteload allocation = TMDL. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Wasteload Allocation (WLA)	The portion of receiving water's load capacity that is allocated to one of its existing or future point sources of pollution. Wasteload allocations specify how much pollutant each point source may release to a water body.
Water Body	A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.
Water Quality Criteria	Levels of water quality expected to render a body of water suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, aquatic habitat, or industrial processes.
Water Quality Standards	State-adopted and United States Environmental Protection Agency-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

Appendix A. Beneficial Uses

Idaho water quality standards (IDAPA 58.01.02) list beneficial uses and set water quality goals for waters of the state. Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses.

Existing Uses

Existing uses under the CWA are "those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards" (40 CFR 131.3). The existing instream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.051.01). Existing uses need to be protected, whether or not the level of water quality to fully support the uses currently exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a water that supported salmonid spawning since November 28, 1975, but does not now due to other factors, such as blockage of migration, channelization, sedimentation, or excess heat.

Designated Uses

Designated uses under the CWA are "those uses specified in water quality standards for each water body or segment, whether or not they are being attained" (40 CFR 131.3). Designated uses are simply uses officially recognized by the state. In Idaho, these include uses such as aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Multiple uses often apply to the same water; in this case, water quality must be sufficiently maintained to meet the most sensitive use (designated or existing). Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are described in the Idaho water quality standards (IDAPA 58.01.02.100) and specifically listed by water body in sections 110–160.

Undesignated Surface Waters and Presumed Use Protection

In Idaho, due to a change in scale of cataloging waters in 2000, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations (IDAPA 58.01.02.110–160). The water quality standards have three sections that address nondesignated waters. Sections 101.02 and 101.03 specifically address nondesignated man-made waterways and private waters. Man-made waterways and private waters have no presumed use protections. Man-made waters are protected for the use for which they were constructed unless otherwise designated in the water quality standards. Private waters are not protected for any beneficial uses unless specifically designated in the water quality standards.

All other undesignated waters are addressed by section 101.01. Under this section, absent information on existing uses, DEQ presumes that most Idaho waters will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called presumed uses, DEQ applies the numeric cold water and recreation criteria to undesignated waters. If in addition to presumed uses, an additional existing use (e.g., salmonid spawning) exists, then the additional numeric criteria for salmonid spawning would also apply (e.g., intergravel dissolved oxygen, temperature) because of the requirement to protect water quality for that existing use. However, if some other use that requires less stringent criteria for protection (such as seasonal cold aquatic life) is found to be an existing use, then a use designation (rulemaking) is needed before that use can be applied in lieu of cold water criteria (IDAPA 58.01.02.101.01).

Appendix B. State and Site-Specific Water Quality Standards and Criteria

Table B1. Selected numeric criteria supportive of designated beneficial uses in Idaho water quality standards.

Parameter	Primary Contact Recreation	Secondary Contact Recreation	Cold Water Aquatic Life	Salmonid Spawning[a]
Water Quality Standards: IDAPA 58.01.02.250–251				
Bacteria				
Geometric mean	<126 *E. coli*/100 mL[b]	<126 *E. coli*/100 mL	—	—
Single sample trigger for additional monitoring	≤406 *E. coli*/100 mL	≤576 *E. coli*/100 mL	—	—
Temperature[c]	—	—	22 °C or less daily maximum; 19 °C or less daily average **Seasonal Cold Water**: Between summer solstice and autumn equinox: 26 °C or less daily maximum; 23 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average[a] **Bull Trout**: Not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June–August; not to exceed 9 °C daily average in September and October [a]

[a] During spawning and incubation periods for inhabiting species
[b] *Escherichia coli* per 100 milliliters
[c] Temperature exemption: Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the 90th percentile of the 7-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.

Water Quality Standards Applicable to Salmonid Spawning Temperature

Water quality standards for temperature are specific numeric values not to be exceeded during the salmonid spawning and egg incubation period, which varies by species. For spring-spawning salmonids, the default spawning and incubation period recognized by the Idaho Department of Environmental Quality (DEQ) is generally March 15 to July 15 (DEQ 2016b). Fall spawning can occur as early as September 1 and continue with incubation into the following spring up to June 1. As per IDAPA 58.01.02.250.02.f.ii., the following water quality criteria need to be met during that time period:

- 13 °C as a daily maximum water temperature
- 9 °C as a daily average water temperature

For the purposes of a temperature TMDL, the highest recorded water temperature in a recorded data set (excluding any high water temperatures that may occur on days when air temperatures exceed the 90th percentile of the highest annual maximum weekly maximum air temperatures) is compared to the daily maximum criterion of 13 °C. The difference between the two water temperatures represents the temperature reduction necessary to achieve compliance with temperature standards.

Natural Background Provisions

For potential natural vegetation temperature TMDLs, it is assumed that natural temperatures may exceed these criteria during certain periods. If potential natural vegetation targets are achieved yet stream temperatures are warmer than these criteria, it is assumed that the stream's temperature is natural (provided no point sources or human-induced ground water sources of heat exist) and natural background provisions of Idaho water quality standards apply:

> When natural background conditions exceed any applicable water quality criteria set forth in Sections 210, 250, 251, 252, or 253, the applicable water quality criteria shall not apply; instead, there shall be no lowering of water quality from natural background conditions. Provided, however, that temperature may be increased above natural background conditions when allowed under Section 401. (IDAPA 58.01.02.200.09)

Section 401 relates to point source wastewater treatment requirements. In this case, if temperature criteria for any aquatic life use are exceeded due to natural conditions, a point source discharge cannot raise the water temperature by more than 0.3 °C (IDAPA 58.01.02.401.01.c).

Appendix C. Data Sources

Table C1. Data sources for Palisades subbasin assessment and TMDL.

Water Body/Area	Data Source	Type of Data	Collection Date
Fall Creek	DEQ Idaho Falls Regional Office	Solar Pathfinder effective shade and stream width	August 2017
		Temperature loggers	August–November 2017
Fall, Gibson, Indian, Sheep, Bear, Antelope, Rainey Creeks and Snake River AUs	DEQ Idaho Falls Regional Office	SEIs	August 2017
Rainey Creek	DEQ Idaho Falls Regional Office	*E. coli* sampling	September 2017
		Temperature loggers	July–November 2017
Palisades subbasin	DEQ State Technical Services Office	PNV data	2017–Variable
Rainey and Fall Creeks	DEQ IDASA Database	Temperature	Variable
Palisades subbasin	Bureau of Land Management—Upper Snake Field Office	Restoration projects	November 2017
Palisades subbasin	US Forest Service—Caribou Targhee National Forest	GIS beaver data, electrofishing data, and restoration projects	November 2017–January 2018
Palisades subbasin	IDFG—Upper Snake Regional Office	Restoration projects and fishery management information	November 2017–January 2018
Palisades subbasin	Trout Unlimited	Restoration projects	November 2017
Palisades subbasin	IDWR website—GIS data	Points of diversion—water rights shapefiles	December 2017
Palisades subbasin	USGS National Water Information System Web Interface	2017 cumulative streamflow hydrograph builder	December 2017
Rainey Creek	NOAA—Climate Data Website	2017 climatological observations for Swan Valley, Idaho Weather Station #108937	December 2017
Swan Valley and Palisades, Idaho	WRCC—Period of Monthly Climate Summary	Historical temperatures in the Palisades subbasin	November 2017

Table C2. Palisades Predicted Beaver Population—USFS GIS Shapefile Color Symbology (USFS 2012).

Stream Segment Color	Meaning	Explanation
Purple	Currently present	Area is known to be currently occupied by beaver.
Beige	Historic	Areas where signs or information indicate beaver were present in the past, but these areas are currently not occupied by beaver. Area is suitable habitat and may be appropriate for introduction but is currently unoccupied.
Blue	Insufficient habitat	Modeling indicated the potential for habitat, but on the ground knowledge, site specific data, etc., indicates that insufficient amounts of habitat exist to support beaver.
Light green	Reintroduction/historic	Historical habitat that, based on its current habitat conditions and social issues, appears to be a highly suitable area for beaver reintroductions.
Pink	Source, currently present	Area that is known to be currently occupied and where it is believed current beaver populations are at a level that would support removing a small number of individuals that could be used to stock historic habitat.
Dark green	Unknown	N/A
No color indicated		No color indicates that no status has been assigned to that stream segment.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service
Current Location: Elev: 5397 ft. Lat: 43.4372° N Lon: -111.2791° W
Station: **SWAN VALLEY, ID US USC00108937**

Record of Climatological Observations
These data are quality controlled and may not be identical to the original observations.
Generated on 03/02/2018

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Observation Time Temperature: 0800 Observation Time Precipitation: 0800

			Temperature (F)			Precipitation					Evaporation		Soil Temperature (F)					
			24 Hrs. Ending at Observation Time		At Observation	24 Hour Amounts Ending at Observation Time				At Obs. Time			4 in. Depth			8 in. Depth		
Year	Month	Day	Max.	Min.		Rain, Melted Snow, Etc. (in)	Flag	Snow, Ice Pellets, Hail (in)	Flag	Snow, Ice Pellets, Hail, Ice on Ground (in)	24 Hour Wind Movement (mi)	Amount of Evap. (in)	Ground Cover (see *)	Max.	Min.	Ground Cover (see *)	Max.	Min.
2017	09	01	74	46	48	0.00		0.0		0								
2017	09	02	83	41	50	0.00		0.0		0								
2017	09	03	90	46	49	0.00		0.0		0								
2017	09	04	90	44	45	0.00		0.0		0								
2017	09	05	91	44	45	0.00		0.0		0								
2017	09	06	81	45	54	0.00		0.0		0								
2017	09	07	83	42	44	0.00		0.0		0								
2017	09	08	83	44	48	0.00		0.0		0								
2017	09	09	81	48	53	0.00		0.0		0								
2017	09	10	81	53	60	0.00		0.0		0								
2017	09	11	80	45	45	0.00		0.0		0								
2017	09	12	85	45	46	0.00		0.0		0								
2017	09	13	87	46	55	0.00		0.0		0								
2017	09	14	80	54	55	0.01		0.0		0								
2017	09	15	69	46	46	0.73		0.0		0								
2017	09	16	51	36	37	0.27		0.0		0								
2017	09	17	49	37	41	0.02		0.0		0								
2017	09	18	68	41	44	0.00		0.0		0								
2017	09	19	71	40	40	0.23		0.0		0								
2017	09	20	55	39	39	0.00		0.0		0								
2017	09	21	59	35	36	0.87		0.0		0								
2017	09	22	42	36	40	0.32		0.0		0								
2017	09	23	46	31	34	0.05		0.0		0								
2017	09	24	52	30	36	0.00		0.0		0								
2017	09	25	57	35	35	0.06		0.0		0								
2017	09	26	54	35	40	0.00		0.0		0								
2017	09	27	61	29	30	0.00		0.0		0								
2017	09	28	66	30	32	0.00		0.0		0								
2017	09	29	68	32	34	0.00		0.0		0								
2017	09	30	66	34	43	0.00		0.0		0								
		Summary	70	40		2.56		0.0										

Empty, or blank, cells indicate that a data observation was not reported.
*Ground Cover: 1=Grass; 2=Fallow; 3=Bare Ground; 4=Brome grass; 5=Sod; 6=Straw mulch; 7=Grass muck; 8=Bare muck; 0=Unknown
"s" This data value failed one of NCDC's quality control tests.
"T" values in the Precipitation or Snow category above indicate a "trace" value was recorded.
"A" values in the Precipitation Flag or the Snow Flag column indicate a multiday total, accumulated since last measurement, is being used.
Data value inconsistency may be present due to rounding calculations during the conversion process from SI metric units to standard imperial units.

Figure C1. Record of climatological observations from Weather Station #108937 in Swan Valley, Idaho (NOAA 2017).

Table C3. Palisades subbasin 2017 field season streambank erosion inventory locations.

Water Body and Assessment Unit	Latitude (Downstream)	Longitude (Downstream)	Latitude (Upstream)	Longitude (Upstream)
Snake River (Upper) ID17040104SK001_02	43.63243	-111.59571	43.63339	-111.59702
Snake River (Lower) ID17040104SK001_02	43.61185	-111.56718	43.61282	-111.56966
Antelope Creek ID17040104SK002_02	43.46218	-111.56359	43.46051	-111.56204
Fall Creek (Gibson Creek) ID17040104SK006_02	43.37455	-111.51883	43.37605	-111.52034
Fall Creek (Gibson Creek) ID17040104SK006_03	43.36978	-111.50206	43.36815	-111.50538
Fall Creek (Lower) ID17040104SK006_04	43.38150	-111.47829	43.38042	-111.47992
Fall Creek II (Upper) ID17040104SK006_04	43.370238	-111.496848	43.369936	-111.497340
Snake River (Indian Creek) ID17040104SK008_02	43.40517	-111.32289	43.40418	-111.32486
Snake River (Sheep Creek) ID17040104SK008_02	43.35894	-111.20059	43.36098	-111.19743
Bear Creek ID17040104SK011_04	43.27679	-111.22595	43.27880	-111.22413
Bear Creek ID17040104SK013_02	43.25654	-111.44564	43.25676	-111.44791
Bear Creek ID17040104SK013_03	43.25082	-111.37955	43.24908	-111.38338
Indian Creek ID17040104SK024_04	43.25887	-111.07214	43.25953	-111.06653
Rainey Creek (Upper) ID17040104SK028_04	43.45925	-111.26566	43.46346	-111.25760
Rainey Creek (Lower) ID17040104SK028_04	43.44882	-111.33272	43.44629	-111.33021

Palisades Subbasin 2017 SEI Data Sheets

Table C4. SEI calculation worksheet for Unnamed Upper Creek—Snake River (ID17040104SK001_02).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Unnamed Upper Creek (Snake River)	**Stream Segment Location (DD)**	
Assessment Unit:	17040104SK001_02	***Upstream N***	43.633390
Segment Inventoried:		***W***	-111.597020
Total Reach:	3,609 ft.	***Downstream N***	43.632430
Date Collected:	8.7.17	***W***	-111.595710
Field Crew:	G. Lehotsky, M. Shumar	**Notes:**	Sediment in creek is due to culverts, unpaved road, and animal access.
Data Reduced By:	G. Lehotsky		

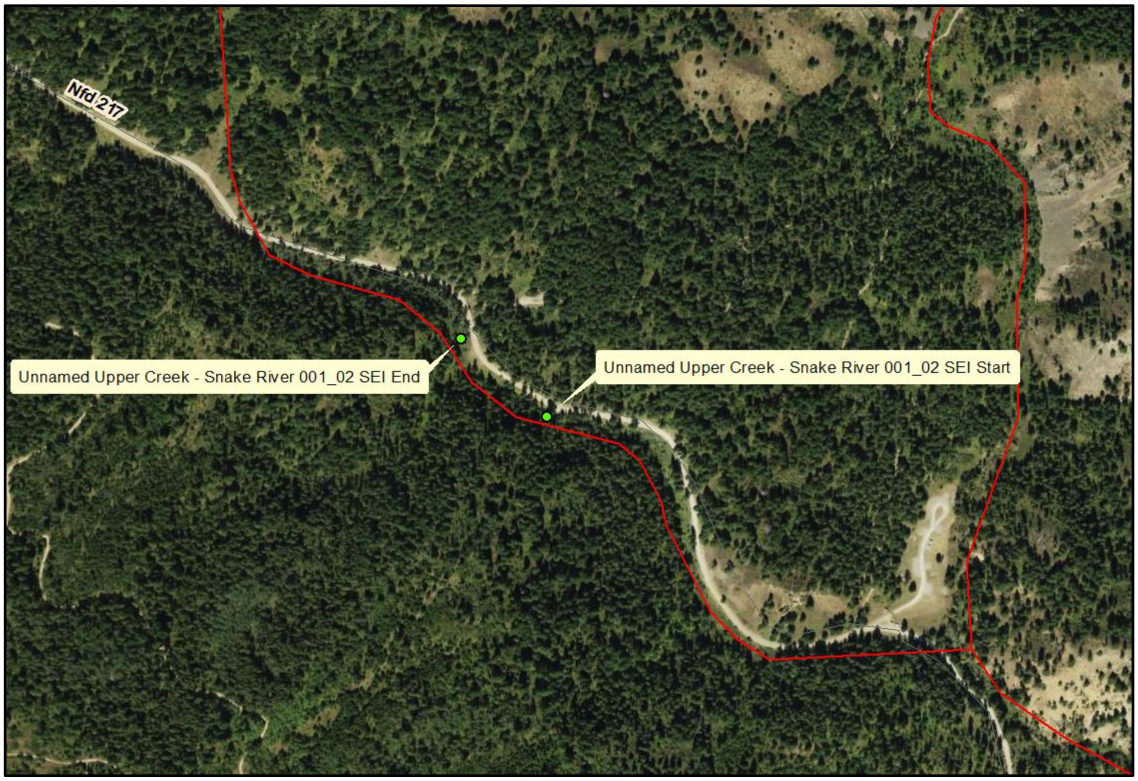
Current Load Streambank Erosion Calculations		**Unit**	**Area Applied**
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	1558.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	100	lb/ft^3	Total Reach
Length of Similar Stream	3609	ft	Total Reach
Estimated Distance inventoried	3116.00	ft	"
Total Erosive Bank Length	117.50	ft	"
Percent Erosive Bank	3.8	%	"
Eroding Area (AE)	281.46	ft^2	"
Lateral Recession Rate (RLR)	0.0575		"
Bank Erosion (E)	0.81	tons/year	"
Total Bank Erosion Rate (ER)	2.74	tons/mile/year	Reach and Segment
Total Bank Erosion	1.87	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	1.25	1.25
Bank Stability Condition (0 to 3)	1	1
Bank Cover/Vegetation(0 to 3)	0.5	0.5
Lateral Channel Stability (0 to 3)	0.25	0.25
Channel Bottom Stability (0 to 2)	1.5	1.5
In-Channel Deposition (-1 to 1)	0.25	0.25
Total = Slight (0-4); Moderate (4-8); Severe (>8)	4.75	4.75
Lateral Recession Rate (RLR) (ft/yr)	**0.0575**	**0.0575**

Load Capacity Streambank Erosion Calculations for Total Reach		**Unit**	**Area Applied**
Eroding Area at Load Capacity (AE)	1492.82	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	4.29	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	14.54	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	9.94	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
2.7	**1.9**	**14.5**	**9.9**	**No**	**1**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Nfd 217
Unnamed Upper Creek - Snake River 001_02 SEI End
Unnamed Upper Creek - Snake River 001_02 SEI Start


08/07/2017

Table C5. SEI calculation worksheet for Unnamed Lower Creek—Snake River (ID17040104SK001_02).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Unnamed Low er Creek (Snake River)	Stream Segment Location (DD)	
Assessment Unit:	17040104SK001_02	Upstream N	43.612820
Segment Inventoried:		W	-111.569660
Total Reach:	6,247 ft.	Downstream N	43.611850
Date Collected:	8.7.17	W	-111.567180
Field Crew:	G. Lehotsky, M. Shumar	Notes:	Storm water runoff from unpaved road to stream is evident. There are bottlenecks in the dry stream.
Data Reduced By:	G. Lehotsky		

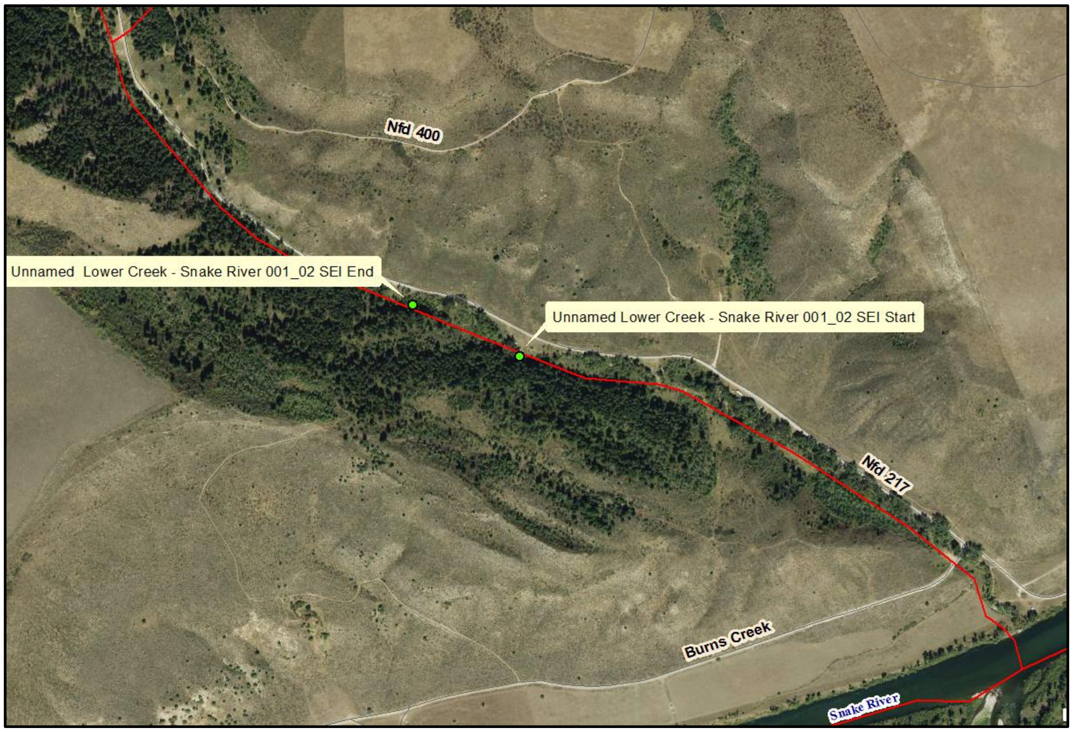
Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalw eg Length (LBB) (stream flow path distance)	1016.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	105	lb/ft^3	Total Reach
Length of Similar Stream	6247	ft	Total Reach
Estimated Distance inventoried	2032.00	ft	"
Total Erosive Bank Length	32.30	ft	"
Percent Erosive Bank	1.6	%	"
Eroding Area (AE)	43.41	ft^2	"
Lateral Recession Rate (RLR)	0.015		"
Bank Erosion (E)	0.03	tons/year	"
Total Bank Erosion Rate (ER)	0.18	tons/mile/year	Reach and Segment
Total Bank Erosion	0.21	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	0.25	0.25
Bank Stability Condition (0 to 3)	0.25	0.25
Bank Cover/Vegetation(0 to 3)	0.25	0.25
Lateral Channel Stability (0 to 3)	0.25	0.25
Channel Bottom Stability (0 to 2)	0	0
In-Channel Deposition (-1 to 1)	-0.5	-0.5
Total = Slight (0-4); Moderate (4-8); Severe (>8)	0.5	0.5
Lateral Recession Rate (RLR) (ft/yr)	**0.015**	**0.015**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	546.19	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	0.43	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	2.24	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	2.64	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
0.2	**0.2**	**2.2**	**2.6**	**No**	**0**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Nfd 400
Unnamed Lower Creek - Snake River 001_02 SEI End
Unnamed Lower Creek - Snake River 001_02 SEI Start
Nfd 217
Burns Creek
Snake River


08/07/2017

Table C6. SEI calculation worksheet for Antelope Creek (ID17040104SK002_02).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Antelope Creek	Stream Segment Location (DD)	
Assessment Unit:	17040104SK002_02	*Upstream N*	43.460510
Segment Inventoried:		*W*	-111.562040
Total Reach:	4,717 ft.	*Downstream N*	43.462180
Date Collected:	8.8.17	*W*	-111.563590
Field Crew:	C. Castle, A. Olson	Notes:	Banks outside of bankfull width eroding due to cattle trampling.
Data Reduced By:	G. Lehotsky		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	755.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	100	lb/ft^3	Total Reach
Length of Similar Stream	4717	ft	Total Reach
Estimated Distance inventoried	1510.00	ft	"
Total Erosive Bank Length	161.10	ft	"
Percent Erosive Bank	10.7	%	"
Eroding Area (AE)	166.84	ft^2	"
Lateral Recession Rate (RLR)	0.045		"
Bank Erosion (E)	0.38	tons/year	"
Total Bank Erosion Rate (ER)	2.63	tons/mile/year	Reach and Segment
Total Bank Erosion	2.35	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	0.75	0.75
Bank Stability Condition (0 to 3)	0.75	0.75
Bank Cover/Vegetation(0 to 3)	0.5	0.5
Lateral Channel Stability (0 to 3)	0.5	0.5
Channel Bottom Stability (0 to 2)	0.75	0.75
In-Channel Deposition (-1 to 1)	0.25	0.25
Total = Slight (0-4); Moderate (4-8); Severe (>8)	3.5	3.5
Lateral Recession Rate (RLR) (ft/yr)	**0.045**	**0.045**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	312.76	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	0.70	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	4.92	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	4.40	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
2.6	**2.3**	**4.9**	**4.4**	**No**	**0**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**

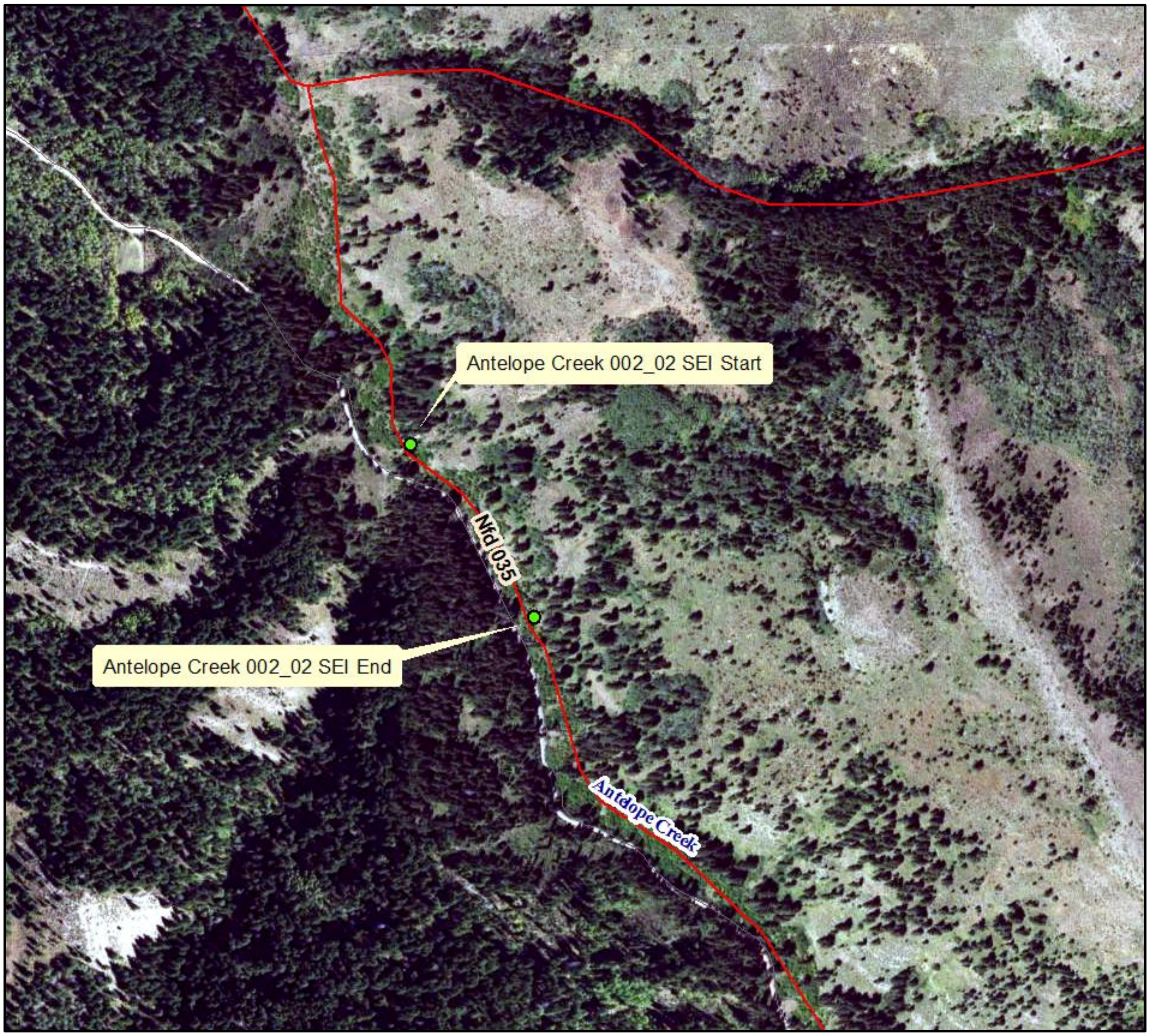

Antelope Creek 002_02 SEI Start
Antelope Creek 002_02 SEI End
Nfd 035
Antelope Creek

Table C7. SEI calculation worksheet for Gibson Creek (ID17040104SK006_02).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Gibson Creek	**Stream Segment Location (DD)**	
Assessment Unit:	17040104SK006_02	***Upstream N***	43.376050
Segment Inventoried:		***W***	-111.520340
Total Reach:	4,182 ft.	***Downstream N***	43.374550
Date Collected:	8.8.17	***W***	-111.518830
Field Crew:	A. Olson, C. Castle	**Notes:**	Erosion factors: cattle trampling, grazing, storm water runoff, and unpaved roads.
Data Reduced By:	G. Lehotsky		

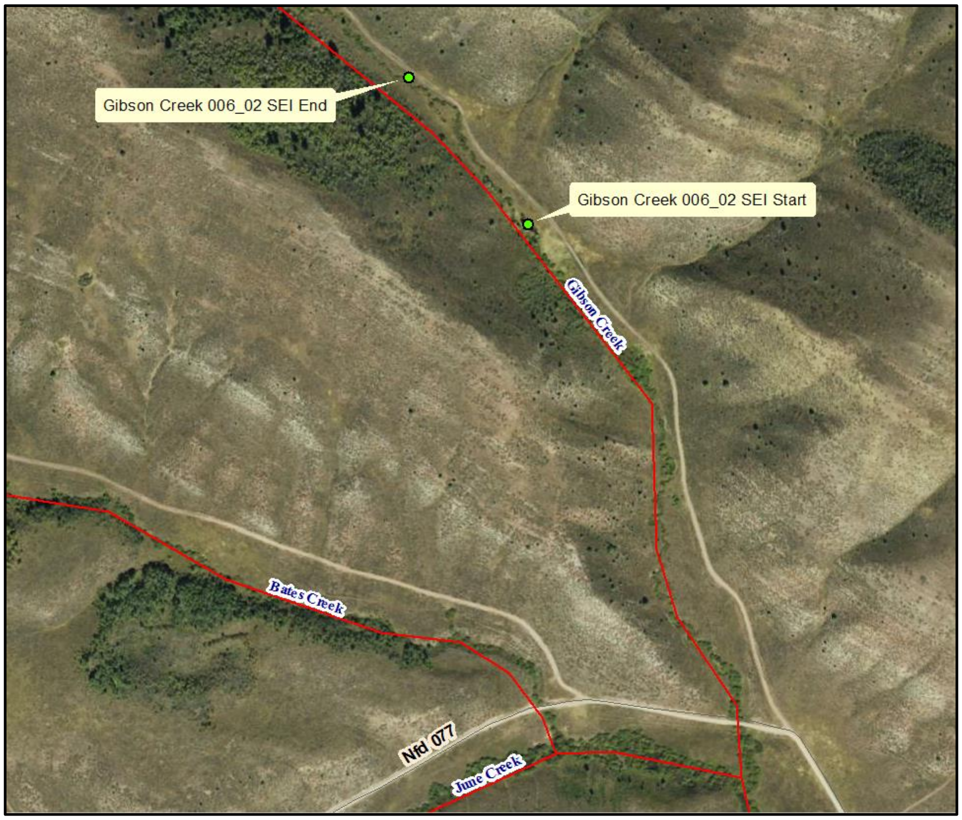
Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	775.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	4182	ft	Total Reach
Estimated Distance inventoried	1550.00	ft	"
Total Erosive Bank Length	199.50	ft	"
Percent Erosive Bank	12.9	%	"
Eroding Area (AE)	206.79	ft^2	"
Lateral Recession Rate (RLR)	0.0425		"
Bank Erosion (E)	0.37	tons/year	"
Total Bank Erosion Rate (ER)	2.54	tons/mile/year	Reach and Segment
Total Bank Erosion	2.02	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	1	1
Bank Stability Condition (0 to 3)	0.5	0.5
Bank Cover/Vegetation(0 to 3)	0.25	0.25
Lateral Channel Stability (0 to 3)	0.25	0.25
Channel Bottom Stability (0 to 2)	0.25	0.25
In-Channel Deposition (-1 to 1)	1	1
Total = Slight (0-4); Moderate (4-8); Severe (>8)	3.25	3.25
Lateral Recession Rate (RLR) (ft/yr)	**0.0425**	**0.0425**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	321.33	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	0.58	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	3.95	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	3.13	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
2.5	**2.0**	**4.0**	**3.1**	**No**	**0**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Gibson Creek 006_02 SEI End
Gibson Creek 006_02 SEI Start
Gibson Creek
Bates Creek
Nfd 077
June Creek


08/08/2017

Table C8. SEI calculation worksheet for Gibson Creek (ID17040104SK006_03).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Gibson Creek	Stream Segment Location (DD)	
Assessment Unit:	17040104SK006_03	Upstream N	43.368150
Segment Inventoried:		W	-111.505380
Total Reach:	6,618 ft.	Downstream N	43.369780
Date Collected:	8.8.17	W	-111.502060
Field Crew:	C. Castle, A. Olson	Notes:	Erosion factors: cattle trampling, grazing, storm water runoff, and unpaved roads.
Data Reduced By:	G. Lehotsky		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	1228.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	6618	ft	Total Reach
Estimated Distance inventoried	2456.00	ft	"
Total Erosive Bank Length	318.00	ft	"
Percent Erosive Bank	12.9	%	"
Eroding Area (AE)	509.43	ft^2	"
Lateral Recession Rate (RLR)	0.06		"
Bank Erosion (E)	1.30	tons/year	"
Total Bank Erosion Rate (ER)	5.59	tons/mile/year	Reach and Segment
Total Bank Erosion	7.00	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	1.25	1.25
Bank Stability Condition (0 to 3)	0.75	0.75
Bank Cover/Vegetation(0 to 3)	0.5	0.5
Lateral Channel Stability (0 to 3)	1	1
Channel Bottom Stability (0 to 2)	1	1
In-Channel Deposition (-1 to 1)	0.5	0.5
Total = Slight (0-4); Moderate (4-8); Severe (>8)	5	5
Lateral Recession Rate (RLR) (ft/yr)	**0.06**	**0.06**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	786.89	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	2.01	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	8.63	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	10.81	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
5.6	**7.0**	**8.6**	**10.8**	**No**	**1**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**

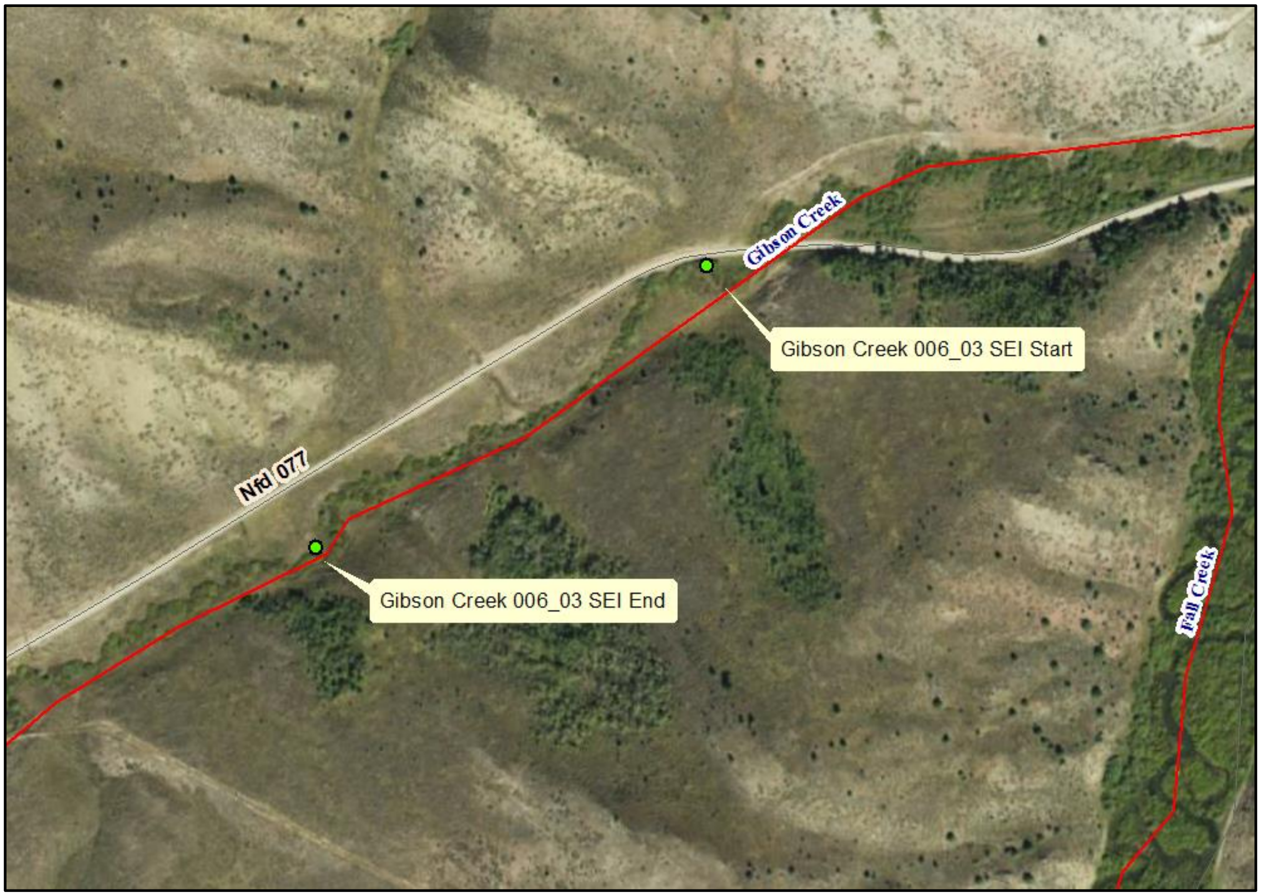

Gibson Creek
Gibson Creek 006_03 SEI Start
Nfd 077
Gibson Creek 006_03 SEI End
Fall Creek

Table C9. SEI calculation worksheet for Lower Fall Creek (ID17040104SK006_04).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Fall Creek	**Stream Segment Location (DD)**	
Assessment Unit:	17040104SK006_04	***Upstream N***	43.380420
Segment Inventoried:		***W***	-111.479920
Total Reach:	5,808 ft.	***Downstream N***	43.381500
Date Collected:	8.8.17	***W***	-111.478290
Field Crew:	G. Lehotsky, M. Shumar, A. Olson, C. Castle	**Notes:**	Stopped SEI at a beaver dam upstream.
Data Reduced By:	G. Lehotsky		

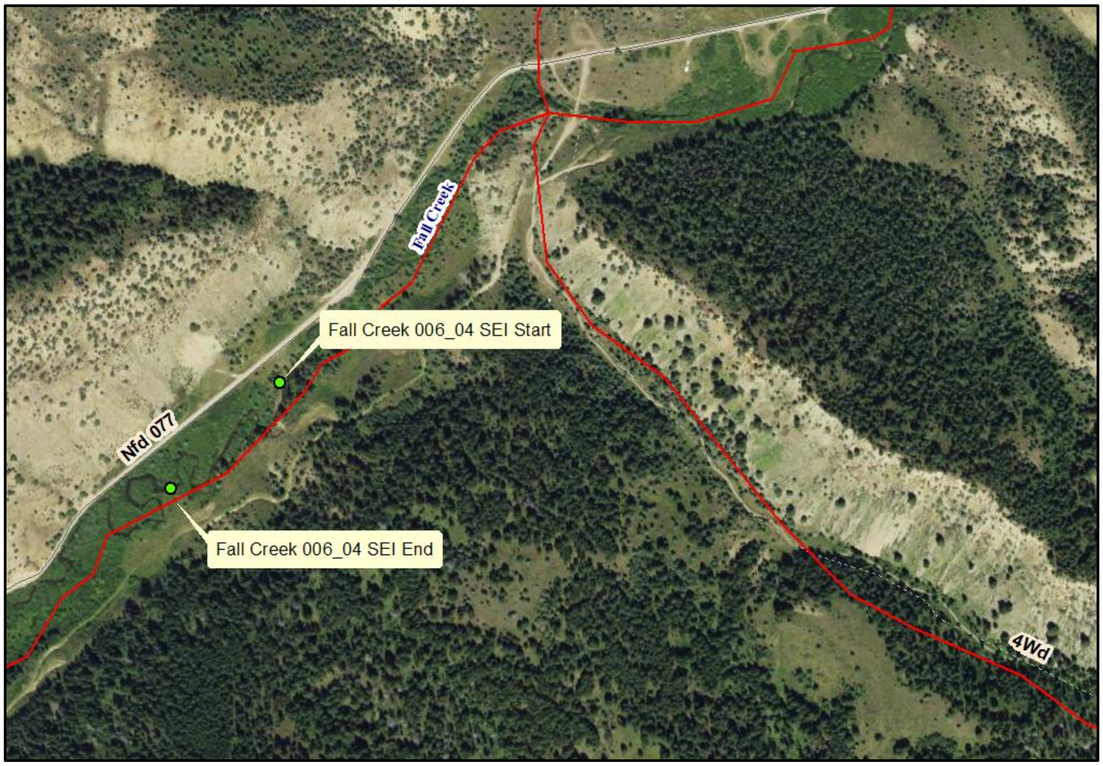
Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	966.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	100	lb/ft^3	Total Reach
Length of Similar Stream	5808	ft	Total Reach
Estimated Distance inventoried	1932.00	ft	"
Total Erosive Bank Length	123.00	ft	"
Percent Erosive Bank	6.4	%	"
Eroding Area (AE)	259.53	ft^2	"
Lateral Recession Rate (RLR)	0.0525		"
Bank Erosion (E)	0.68	tons/year	"
Total Bank Erosion Rate (ER)	3.72	tons/mile/year	Reach and Segment
Total Bank Erosion	4.10	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	1.25	1.25
Bank Stability Condition (0 to 3)	1.25	1.25
Bank Cover/Vegetation(0 to 3)	0.5	0.5
Lateral Channel Stability (0 to 3)	0.25	0.25
Channel Bottom Stability (0 to 2)	0.5	0.5
In-Channel Deposition (-1 to 1)	0.5	0.5
Total = Slight (0-4); Moderate (4-8); Severe (>8)	4.25	4.25
Lateral Recession Rate (RLR) (ft/yr)	**0.0525**	**0.0525**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	815.30	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	2.14	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	11.70	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	12.87	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
3.7	**4.1**	**11.7**	**12.9**	**No**	**1**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Fall Creek
Fall Creek 006_04 SEI Start
Nfd 077
Fall Creek 006_04 SEI End
4Wd


08/08/2017

Table C10. SEI calculation worksheet for Upper Fall Creek II (ID17040104SK006_04).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Fall Creek II	**Stream Segment Location (DD)**	
Assessment Unit:	17040104SK006_04	***Upstream N***	43.369930
Segment Inventoried:		***W***	-111.497340
Total Reach:	6,587 ft.	***Downstream N***	43.370238
Date Collected:	8.8.17	***W***	-111.496848
Field Crew:	C. Castle, A. Olson	**Notes:**	A lot of silt is present due to numerous old beaver dams along the length of the creek.
Data Reduced By:	G. Lehotsky		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (streamflow path distance)	308.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	100	lb/ft^3	Total Reach
Length of Similar Stream	6587	ft	Total Reach
Estimated Distance inventoried	616.00	ft	"
Total Erosive Bank Length	108.00	ft	"
Percent Erosive Bank	17.5	%	"
Eroding Area (AE)	219.91	ft^2	"
Lateral Recession Rate (RLR)	0.075		"
Bank Erosion (E)	0.82	tons/year	"
Total Bank Erosion Rate (ER)	14.14	tons/mile/year	Reach and Segment
Total Bank Erosion	17.64	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	1.5	1.5
Bank Stability Condition (0 to 3)	2	2
Bank Cover/Vegetation(0 to 3)	1	1
Lateral Channel Stability (0 to 3)	1	1
Channel Bottom Stability (0 to 2)	0.5	0.5
In-Channel Deposition (-1 to 1)	-0.5	-0.5
Total = Slight (0-4); Moderate (4-8); Severe (>8)	5.5	5.5
Lateral Recession Rate (RLR) (ft/yr)	**0.075**	**0.075**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	250.86	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	0.94	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	16.13	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	20.12	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
14.1	**17.6**	**16.1**	**20.1**	**No**	**2**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**

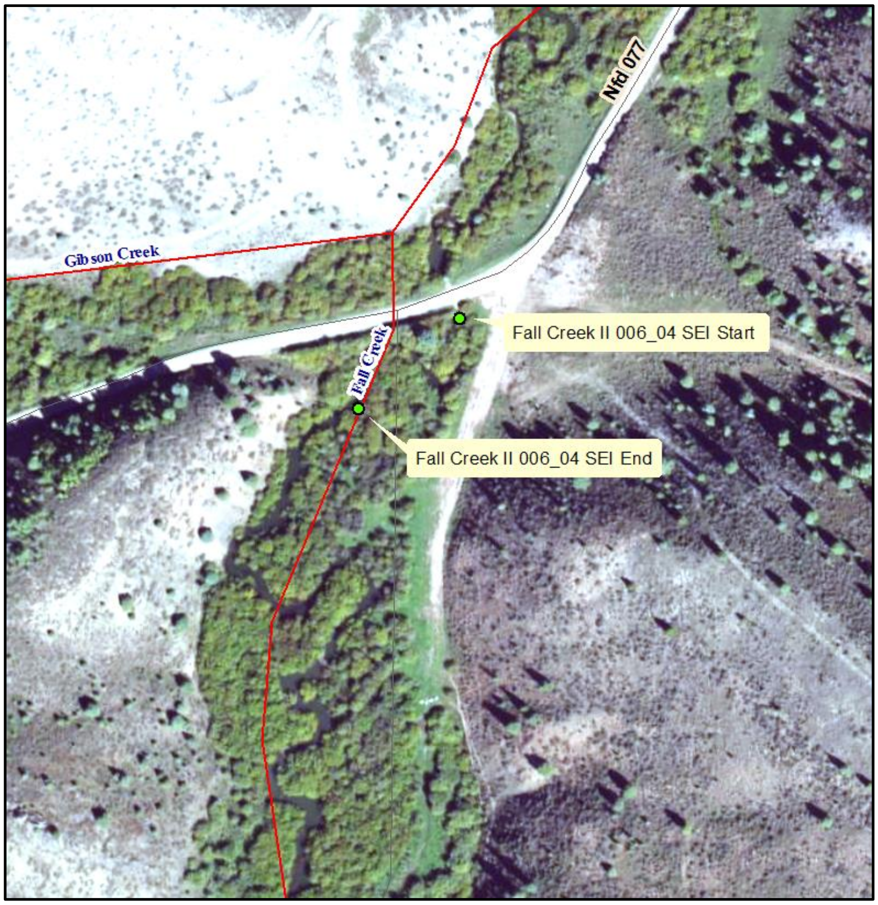

Gib son Creek
Nfd 077
Fall Creek
Fall Creek II 006_04 SEI Start
Fall Creek II 006_04 SEI End

Table C11. SEI calculation worksheet for Indian Creek (ID17040104SK008_02).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Indian Creek (Snake River)	**Stream Segment Location (DD)**	
Assessment Unit:	17040104SK008_02	***Upstream N***	43.404180
Segment Inventoried:		***W***	-111.324860
Total Reach:	3,134 ft.	***Downstream N***	43.405170
Date Collected:	8.8.17	***W***	-111.322890
Field Crew:	G. Lehotsky, M. Shumar	**Notes:**	Most of the noted erosion was due to cattle trampling.
Data Reduced By:	G. Lehotsky		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (streamflow path distance)	748.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	3134	ft	Total Reach
Estimated Distance inventoried	1496.00	ft	"
Total Erosive Bank Length	223.50	ft	"
Percent Erosive Bank	14.9	%	"
Eroding Area (AE)	547.09	ft^2	"
Lateral Recession Rate (RLR)	0.045		"
Bank Erosion (E)	1.05	tons/year	"
Total Bank Erosion Rate (ER)	7.39	tons/mile/year	Reach and Segment
Total Bank Erosion	4.38	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	1.5	1.5
Bank Stability Condition (0 to 3)	0.5	0.5
Bank Cover/Vegetation(0 to 3)	0.25	0.25
Lateral Channel Stability (0 to 3)	0.5	0.5
Channel Bottom Stability (0 to 2)	0.5	0.5
In-Channel Deposition (-1 to 1)	0.25	0.25
Total = Slight (0-4); Moderate (4-8); Severe (>8)	3.5	3.5
Lateral Recession Rate (RLR) (ft/yr)	**0.045**	**0.045**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	732.39	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	1.40	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	9.89	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	5.87	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
7.4	**4.4**	**9.9**	**5.9**	**No**	**1**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**

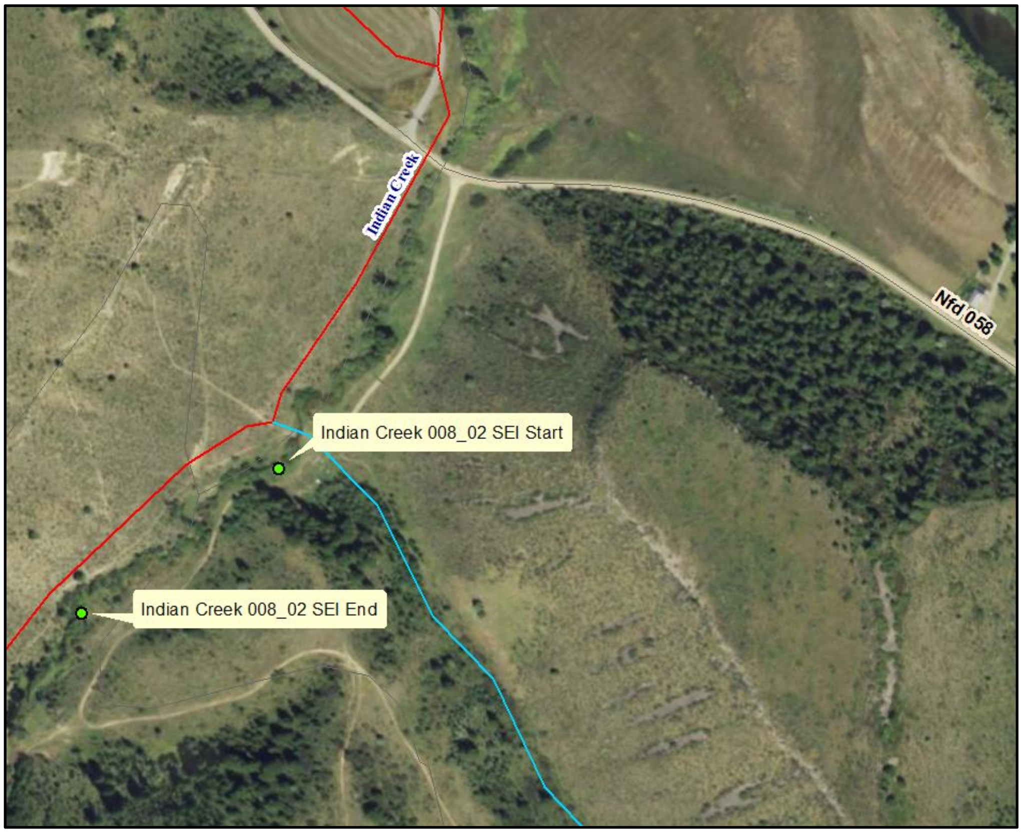

Indian Creek
Nfd 058
Indian Creek 008_02 SEI Start
Indian Creek 008_02 SEI End

Table C12. SEI calculation worksheet for Sheep Creek (ID17040104SK008_02).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Sheep Creek (Snake River)	**Stream Segment Location (DD)**	
Assessment Unit:	17040104SK008_02	***Upstream N***	43.360980
Segment Inventoried:		***W***	-111.197430
Total Reach:	6,099 ft.	***Downstream N***	43.358940
Date Collected:	8.9.17	***W***	-111.200590
Field Crew:	C. Castle, A. Olson	**Notes:**	Majority of erosion noted was due to cattle trampling. There are traces of an old human dammed area.
Data Reduced By:	G. Lehotsky		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	1228.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	6099	ft	Total Reach
Estimated Distance inventoried	2456.00	ft	"
Total Erosive Bank Length	381.10	ft	"
Percent Erosive Bank	15.5	%	"
Eroding Area (AE)	716.97	ft^2	"
Lateral Recession Rate (RLR)	0.0825		"
Bank Erosion (E)	2.51	tons/year	"
Total Bank Erosion Rate (ER)	10.81	tons/mile/year	Reach and Segment
Total Bank Erosion	12.49	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	1.75	1.75
Bank Stability Condition (0 to 3)	0.75	0.75
Bank Cover/Vegetation(0 to 3)	0.5	0.5
Lateral Channel Stability (0 to 3)	1	1
Channel Bottom Stability (0 to 2)	1.25	1.25
In-Channel Deposition (-1 to 1)	0.5	0.5
Total = Slight (0-4); Moderate (4-8); Severe (>8)	5.75	5.75
Lateral Recession Rate (RLR) (ft/yr)	**0.0825**	**0.0825**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	924.10	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	3.24	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	13.93	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	16.09	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
10.8	**12.5**	**13.9**	**16.1**	**No**	**2**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**

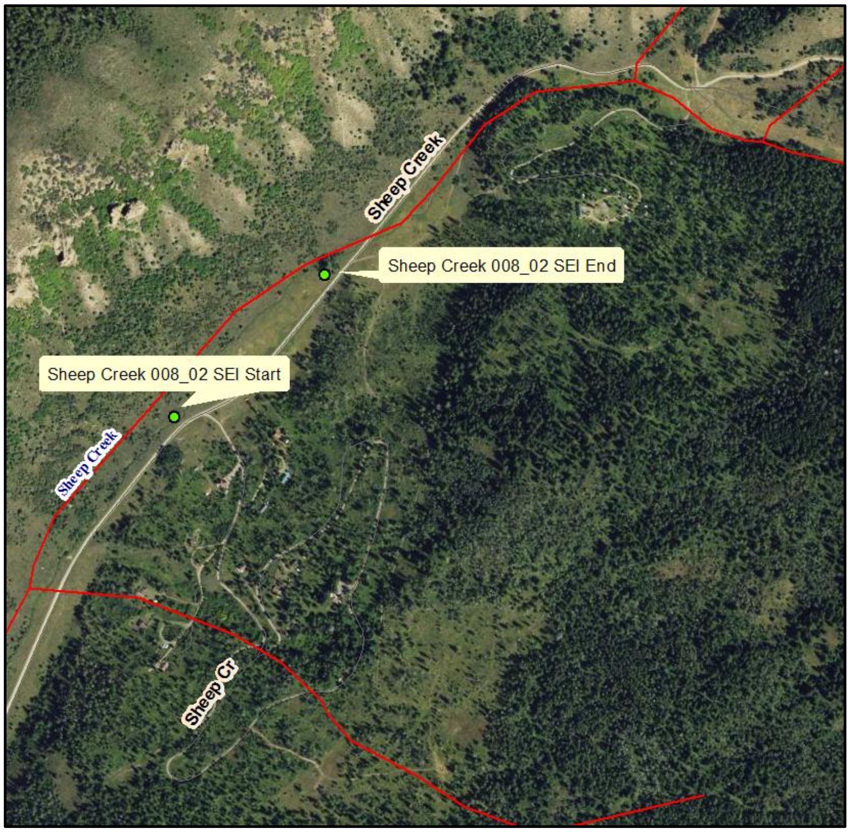

Sheep Creek
Sheep Creek 008_02 SEI End
Sheep Creek 008_02 SEI Start
Sheep Creek
Sheep Cr

Table C13. SEI calculation worksheet for Bear Creek (ID17040104SK011_04).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Bear Creek	**Stream Segment Location (DD)**	
Assessment Unit:	17040104SK011_04	***Upstream N***	43.276790
Segment Inventoried:		***W***	-111.225950
Total Reach:	4,739 ft.	***Downstream N***	43.278800
Date Collected:	8.9.17	***W***	-111.224130
Field Crew:	G. Lehotsky, M. Shumar	**Notes:**	Creek is covered in cobbles, well armored and sinuous.
Data Reduced By:	G. Lehotsky		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flowpath distance)	1301.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	110	lb/ft^3	Total Reach
Length of Similar Stream	4739	ft	Total Reach
Estimated Distance inventoried	2602.00	ft	"
Total Erosive Bank Length	91.80	ft	"
Percent Erosive Bank	3.5	%	"
Eroding Area (AE)	267.48	ft^2	"
Lateral Recession Rate (RLR)	0.03		"
Bank Erosion (E)	0.44	tons/year	"
Total Bank Erosion Rate (ER)	1.79	tons/mile/year	Reach and Segment
Total Bank Erosion	1.61	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	0.25	0.25
Bank Stability Condition (0 to 3)	0.25	0.25
Bank Cover/Vegetation(0 to 3)	0.25	0.25
Lateral Channel Stability (0 to 3)	0.5	0.5
Channel Bottom Stability (0 to 2)	0.5	0.5
In-Channel Deposition (-1 to 1)	0.25	0.25
Total = Slight (0-4); Moderate (4-8); Severe (>8)	2	2
Lateral Recession Rate (RLR) (ft/yr)	**0.03**	**0.03**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	1516.30	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	2.50	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	10.15	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	9.11	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
1.8	**1.6**	**10.2**	**9.1**	**No**	**1**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Red Spring Creek
Bear Creek
Bear Creek
Bear Creek 011_04 SEI End
Bear Creek 011_04 SEI Start
Nfd 058


08/09/2017

Table C14. SEI calculation worksheet for Bear Creek (ID17040104SK013_02).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Bear Creek	Stream Segment Location (DD)	
Assessment Unit:	17040104SK013_02	*Upstream N*	43.256760
Segment Inventoried:		*W*	-111.447910
Total Reach:	5,257 ft.	*Downstream N*	43.256540
Date Collected:	9.11.17	*W*	-111.445640
Field Crew:	G. Lehotsky, C. Castle	Notes:	Creek was dry with many braids. Old beaver dam channels wound around the main channel. Large amounts of vegetation - willows - protecting
Data Reduced By:	G. Lehotsky		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	778.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	5257	ft	Total Reach
Estimated Distance inventoried	1556.00	ft	"
Total Erosive Bank Length	27.50	ft	"
Percent Erosive Bank	1.8	%	"
Eroding Area (AE)	52.85	ft^2	"
Lateral Recession Rate (RLR)	0.055		"
Bank Erosion (E)	0.12	tons/year	"
Total Bank Erosion Rate (ER)	0.84	tons/mile/year	Reach and Segment
Total Bank Erosion	0.83	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	0.5	0.5
Bank Stability Condition (0 to 3)	0.5	0.5
Bank Cover/Vegetation(0 to 3)	0.5	0.5
Lateral Channel Stability (0 to 3)	1.5	1.5
Channel Bottom Stability (0 to 2)	1	1
In-Channel Deposition (-1 to 1)	0.5	0.5
Total = Slight (0-4); Moderate (4-8); Severe (>8)	4.5	4.5
Lateral Recession Rate (RLR) (ft/yr)	**0.055**	**0.055**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	598.07	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	1.40	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	9.49	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	9.45	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
0.8	**0.8**	**9.5**	**9.4**	**No**	**1**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Nfd 077
Bear Creek
Bear Creek 013_02 SEI Start
Bear Creek 013_02 SEI End


09/11/2017

Table C15. SEI calculation worksheet for Bear Creek (ID17040104SK013_03).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Bear Creek	**Stream Segment Location (DD)**	
Assessment Unit:	17040104SK013_03	***Upstream N***	43.249080
Segment Inventoried:		***W***	-111.383380
Total Reach:	10,852 ft.	***Downstream N***	43.250820
Date Collected:	9.29.17	***W***	-111.379550
Field Crew:	G. Lehotsky	**Notes:**	Several beaver dams and many large rocks all along the inventoried segment.
Data Reduced By:	G. Lehotsky		

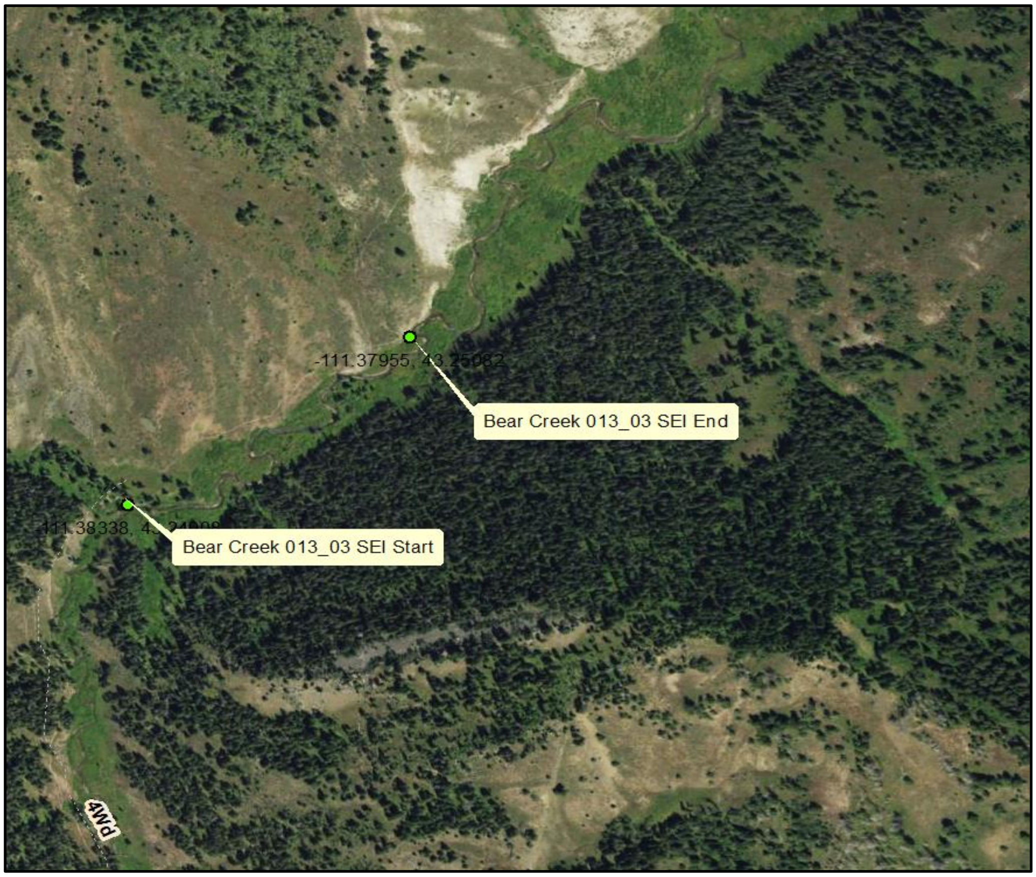
Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	1971.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	110	lb/ft^3	Total Reach
Length of Similar Stream	10852	ft	Total Reach
Estimated Distance inventoried	3942.00	ft	"
Total Erosive Bank Length	382.70	ft	"
Percent Erosive Bank	9.7	%	"
Eroding Area (AE)	1183.51	ft^2	"
Lateral Recession Rate (RLR)	0.15		"
Bank Erosion (E)	9.76	tons/year	"
Total Bank Erosion Rate (ER)	26.16	tons/mile/year	Reach and Segment
Total Bank Erosion	53.76	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	3	3
Bank Stability Condition (0 to 3)	1	1
Bank Cover/Vegetation(0 to 3)	1	1
Lateral Channel Stability (0 to 3)	2	2
Channel Bottom Stability (0 to 2)	0.5	0.5
In-Channel Deposition (-1 to 1)	0.5	0.5
Total = Slight (0-4); Moderate (4-8); Severe (>8)	8	8
Lateral Recession Rate (RLR) (ft/yr)	**0.15**	**0.15**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	2438.15	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	20.11	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	53.88	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	110.75	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
26.2	**53.8**	**53.9**	**110.7**	**No**	**11**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Bear Creek 013_03 SEI End
Bear Creek 013_03 SEI Start
4WD


09/29/2017

Table C16. SEI calculation worksheet for Indian Creek (ID17040104SK024_04).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Indian Creek	**Stream Segment Location (DD)**	
Assessment Unit:	17040104SK024_04	***Upstream N***	43.259830
Segment Inventoried:		***W***	-111.066530
Total Reach:	6,500 ft.	***Downstream N***	43.258870
Date Collected:	8.9.17	***W***	-111.072140
Field Crew:	G. Lehotsky, M. Shumar	**Notes:**	Stream was full of cobbles. Primarily slough/carve instability along this reach.
Data Reduced By:	G. Lehotsky		

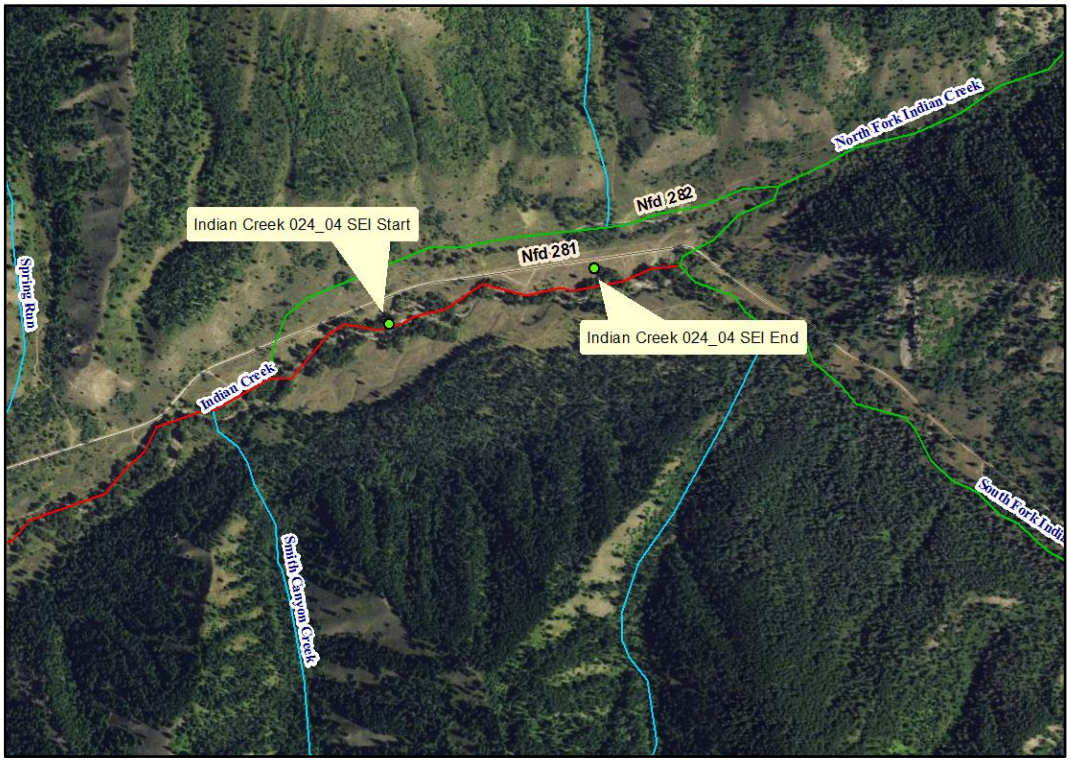
Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	1913.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	110	lb/ft^3	Total Reach
Length of Similar Stream	6500	ft	Total Reach
Estimated Distance inventoried	3826.00	ft	"
Total Erosive Bank Length	611.30	ft	"
Percent Erosive Bank	16.0	%	"
Eroding Area (AE)	4454.86	ft^2	"
Lateral Recession Rate (RLR)	0.0825		"
Bank Erosion (E)	20.21	tons/year	"
Total Bank Erosion Rate (ER)	55.79	tons/mile/year	Reach and Segment
Total Bank Erosion	68.68	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	1.25	1.25
Bank Stability Condition (0 to 3)	1.5	1.5
Bank Cover/Vegetation(0 to 3)	0.5	0.5
Lateral Channel Stability (0 to 3)	1	1
Channel Bottom Stability (0 to 2)	1	1
In-Channel Deposition (-1 to 1)	0.5	0.5
Total = Slight (0-4); Moderate (4-8); Severe (>8)	5.75	5.75
Lateral Recession Rate (RLR) (ft/yr)	**0.0825**	**0.0825**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	5576.40	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	25.30	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	69.84	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	85.97	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
55.8	**68.7**	**69.8**	**86.0**	**No**	**9**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


North Fork Indian Creek
Nfd 282
Indian Creek 024_04 SEI Start
Nfd 281
Spring Run
Indian Creek 024_04 SEI End
Indian Creek
South Fork Indi
Smith Canyon Creek


08/09/2017

Table C17. SEI calculation worksheet for Upper Rainey Creek (ID17040104SK028_04).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Rainey Creek - Upper	Stream Segment Location (DD)	
Assessment Unit:	17040104SK028_04	*Upstream N*	43.463460
Segment Inventoried:		*W*	-111.257600
Total Reach:	7,622 ft.	*Downstream N*	43.459250
Date Collected:	10.24.17	*W*	-111.265660
Field Crew:	C. Castle, A. Lugar, G. Lehotsky	Notes:	Minor erosion due to a number of fenced off banks, as well as restoration efforts along the banks and at the water's edge.
Data Reduced By:	G. Lehotsky		

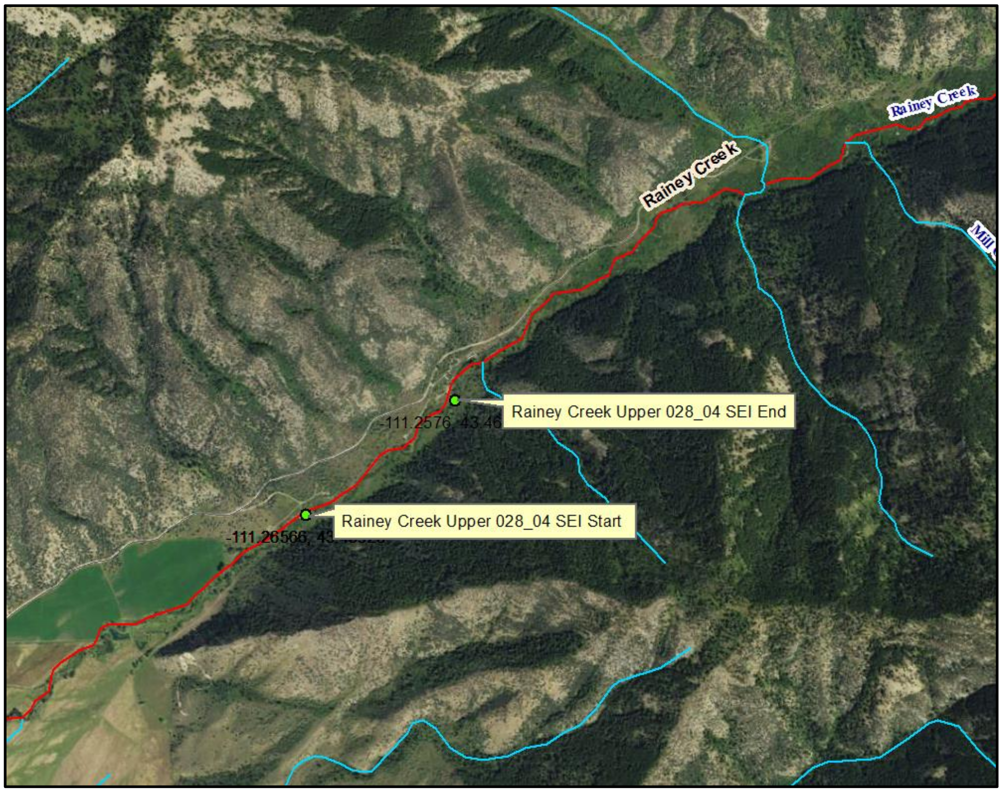
Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	3156.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	105	lb/ft^3	Total Reach
Length of Similar Stream	7622	ft	Total Reach
Estimated Distance inventoried	6312.00	ft	"
Total Erosive Bank Length	60.20	ft	"
Percent Erosive Bank	1.0	%	"
Eroding Area (AE)	85.81	ft^2	"
Lateral Recession Rate (RLR)	0.03		"
Bank Erosion (E)	0.14	tons/year	"
Total Bank Erosion Rate (ER)	0.23	tons/mile/year	Reach and Segment
Total Bank Erosion	0.33	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	0.75	0.75
Bank Stability Condition (0 to 3)	0.25	0.25
Bank Cover/Vegetation(0 to 3)	0.5	0.5
Lateral Channel Stability (0 to 3)	0.25	0.25
Channel Bottom Stability (0 to 2)	0.25	0.25
In-Channel Deposition (-1 to 1)	0	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	2	2
Lateral Recession Rate (RLR) (ft/yr)	**0.03**	**0.03**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	1799.44	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	2.83	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	4.74	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	6.84	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
0.2	**0.3**	**4.7**	**6.8**	**No**	**1**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Rainey Creek
Rainey Creek
Rainey Creek Upper 028_04 SEI End
Rainey Creek Upper 028_04 SEI Start


10/24/2017

Table C18. SEI calculation worksheet for Lower Rainey Creek (ID17040104SK028_04).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

		Stream Segment Location (DD)	
Stream:	Rainey Creek - Lower		
Assessment Unit:	17040104SK028_04	***Upstream N***	43.446290
Segment Inventoried:		***W***	-111.330210
Total Reach:	4,548 ft.	***Downstream N***	43.448820
Date Collected:	10.24.17	***W***	-111.332720
Field Crew:	C. Castle, A. Lugar, G. Lehotsky	**Notes:**	Beaver Dam located on this reach. Fenced on both sides of creek. There is a USFS horse paddock adjacent to the creek.
Data Reduced By:	G. Lehotsky		

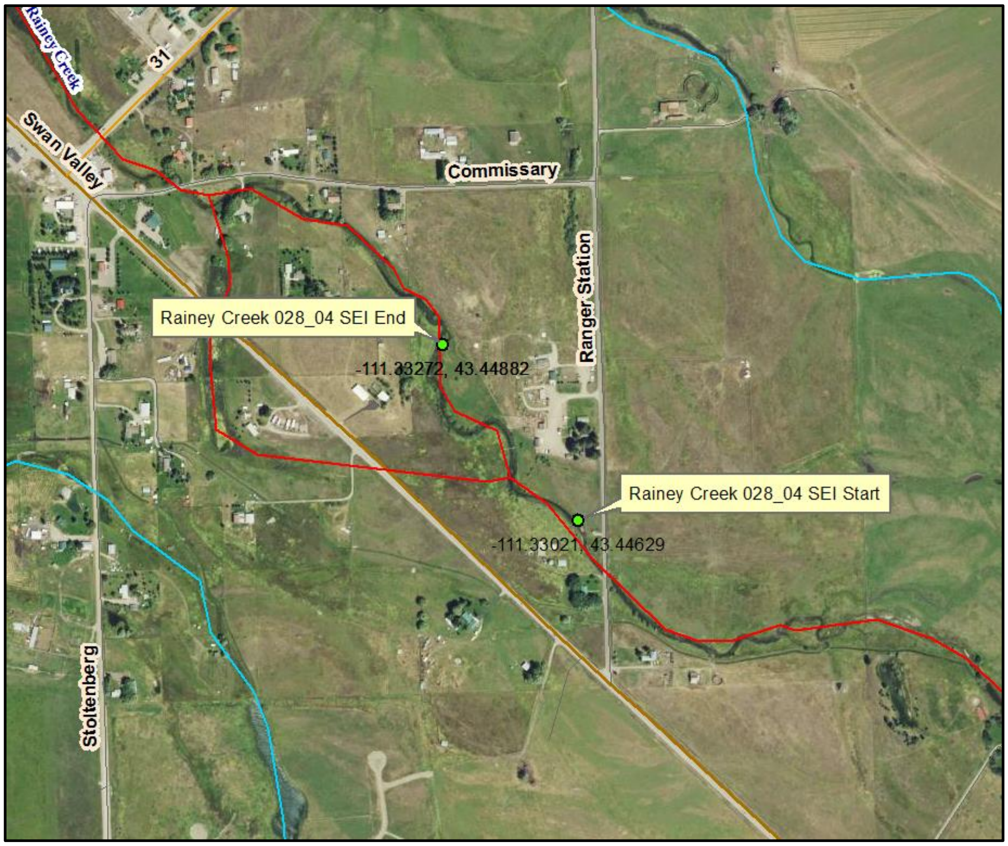
Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	1455.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	105	lb/ft^3	Total Reach
Length of Similar Stream	4548	ft	Total Reach
Estimated Distance inventoried	2910.00	ft	"
Total Erosive Bank Length	114.00	ft	"
Percent Erosive Bank	3.9	%	"
Eroding Area (AE)	1201.30	ft^2	"
Lateral Recession Rate (RLR)	0.0275		"
Bank Erosion (E)	1.73	tons/year	"
Total Bank Erosion Rate (ER)	6.29	tons/mile/year	Reach and Segment
Total Bank Erosion	5.42	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	0.5	0.5
Bank Stability Condition (0 to 3)	0.25	0.25
Bank Cover/Vegetation(0 to 3)	0.5	0.5
Lateral Channel Stability (0 to 3)	0.25	0.25
Channel Bottom Stability (0 to 2)	0.25	0.25
In-Channel Deposition (-1 to 1)	0	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	1.75	1.75
Lateral Recession Rate (RLR) (ft/yr)	**0.0275**	**0.0275**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	6132.95	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	8.85	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	32.13	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	27.68	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
6.3	**5.4**	**32.1**	**27.7**	**No**	**3**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Rainey Creek
31
Swan Valley
Commissary
Ranger Station
Rainey Creek 028_04 SEI End
-111.33272, 43.44882
Rainey Creek 028_04 SEI Start
-111.33021, 43.44629
Stoltenberg


10/24/2017

Palisades Subbasin Temperature Logger Data

Table C19. Temperature logger locations.

Location and Assessment Unit	Latitude	Longitude	Logger #
June Creek #Fall C2 ID17040104SK006_02	43.36932	-111.51850	10546359
Gibson Creek #Fall C3 ID17040104SK006_03	43.37014	-111.49924	10546365
Fall Creek #Fall C1 ID17040104SK006_04	43.39471	-111.45187	10546358
Rainey Creek #RC1 (Lower AU) ID17040104SK028_04	43.45481	-111.34680	10349112
Rainey Creek #RC2 (Mid-AU) ID17040104SK028_04	43.44948	-111.28689	10349115
Rainey Creek #RC4 (Upper AU) ID17040104SK028_04	43.45907	-111.26585	10102539

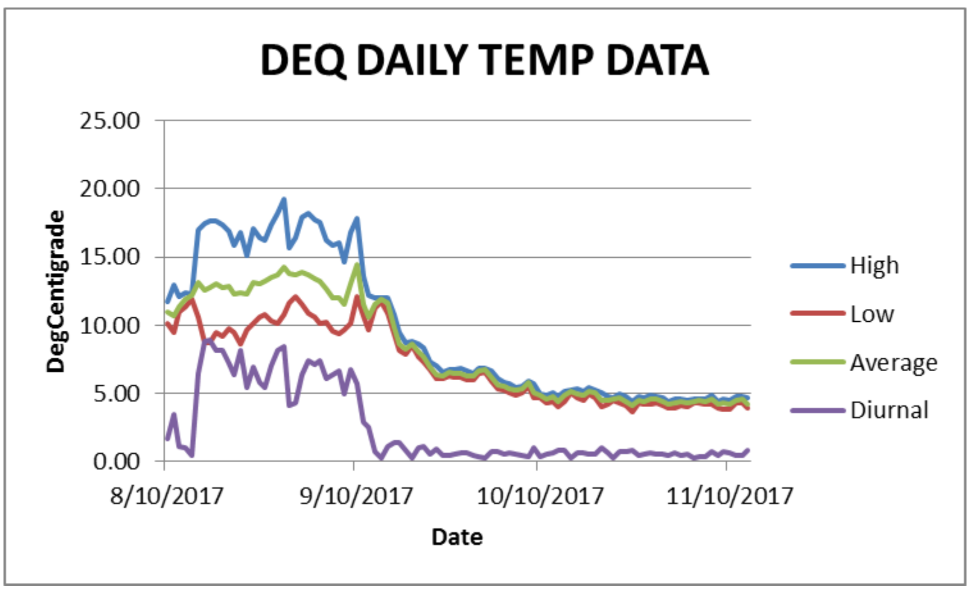


Figure C2. Temperature data for June Creek at location #Fall C2.

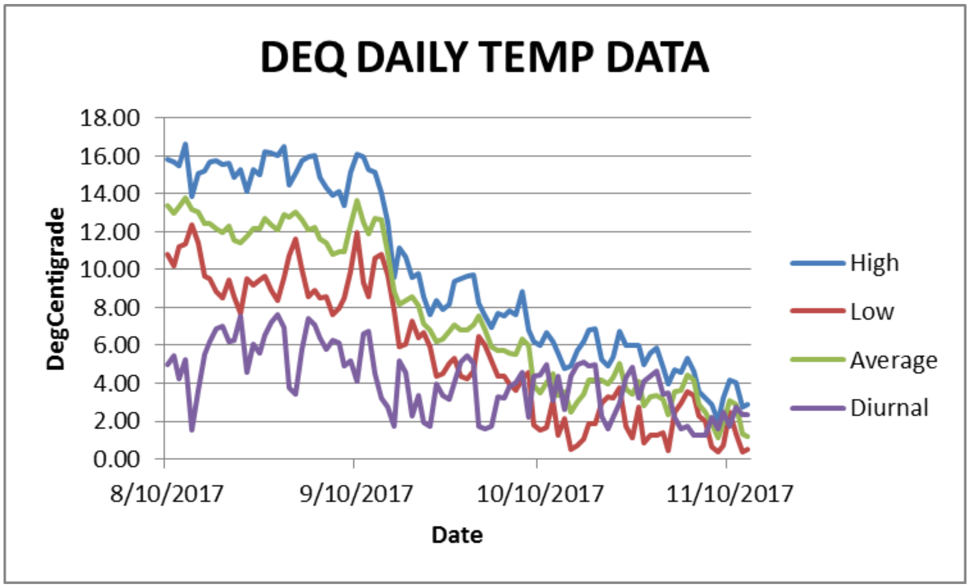


Figure C3. Temperature data for Gibson Creek at location #Fall C3.

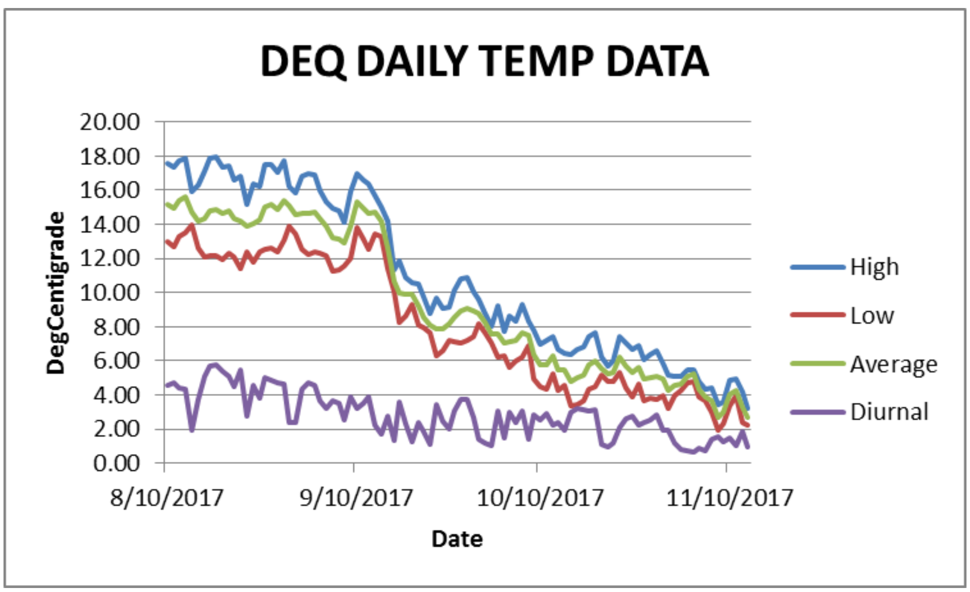


Figure C4. Temperature data for Fall Creek at location #Fall C1.

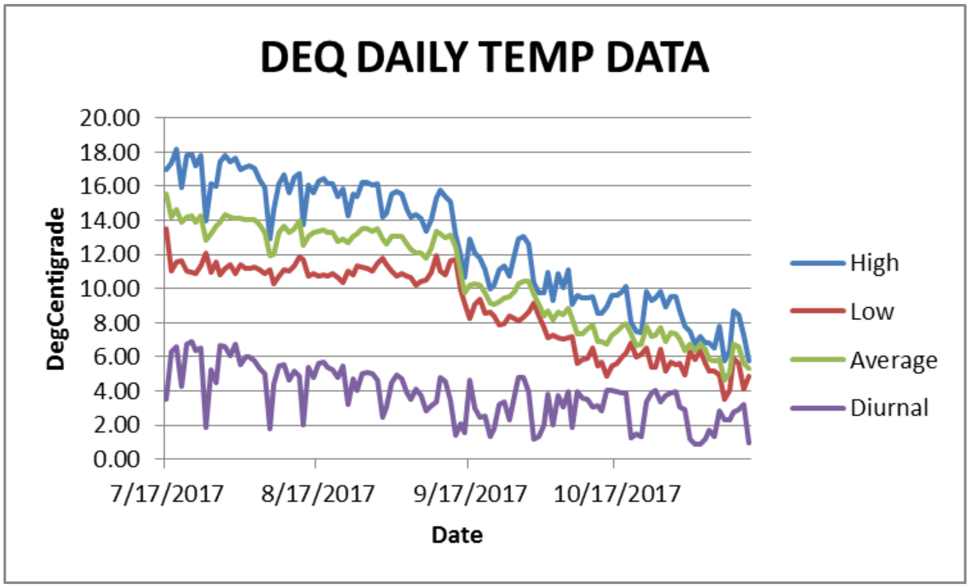


Figure C5. Temperature data for Rainey Creek at location #RC1.

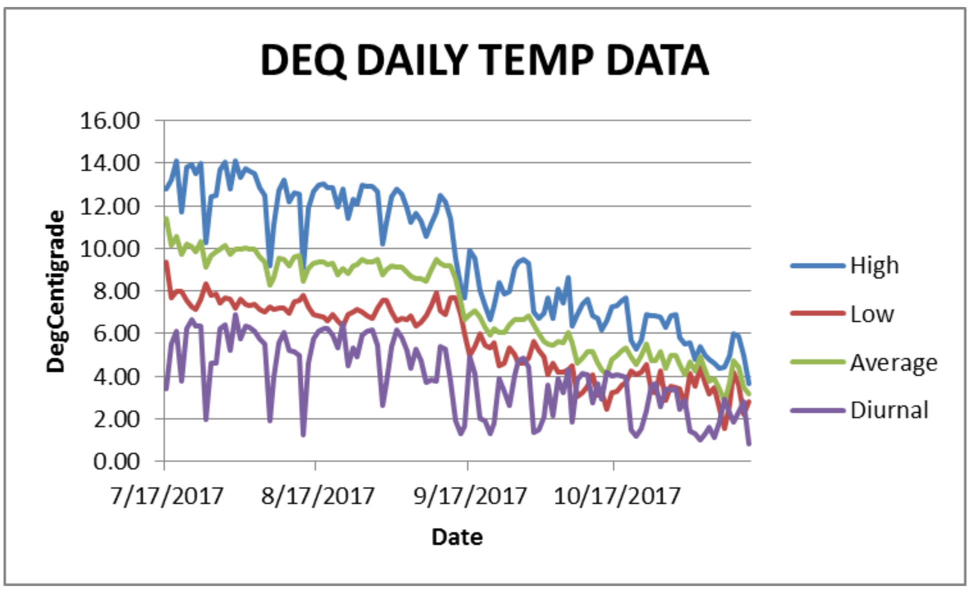


Figure C6. Temperature data for Rainey Creek at location #RC2.

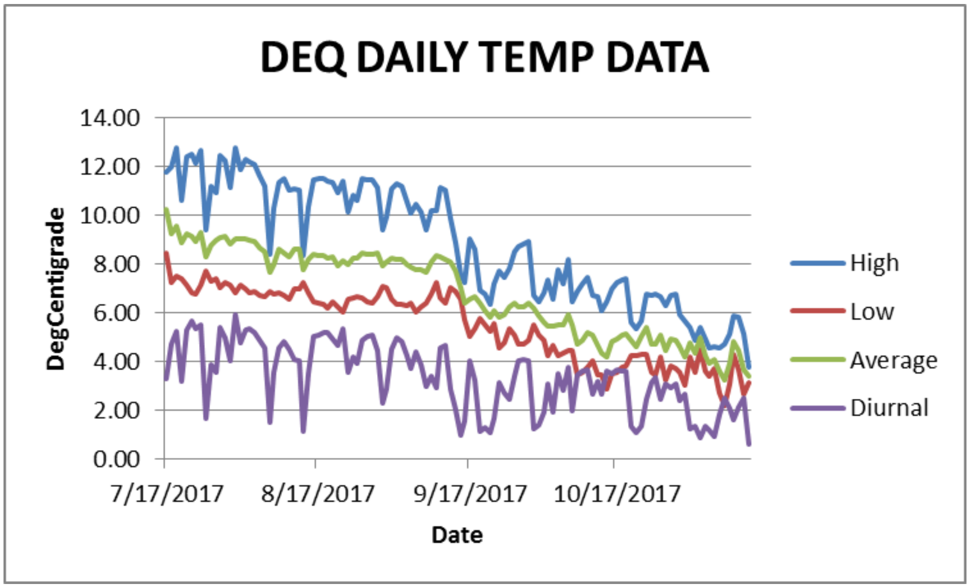
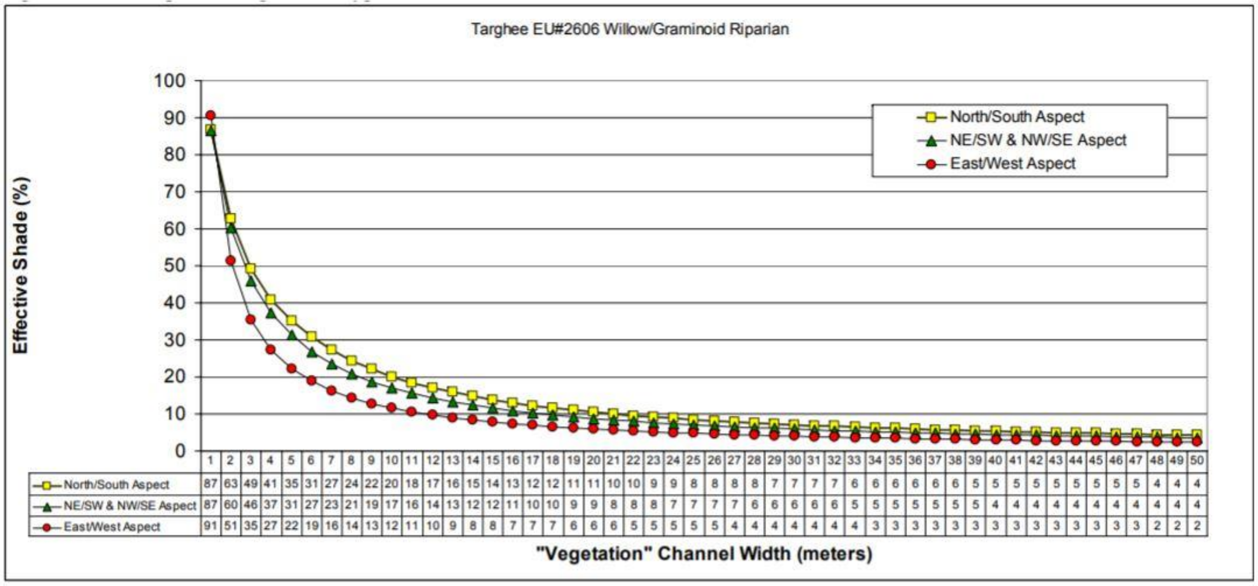


Figure C7. Temperature data for Rainey Creek at location #RC4.

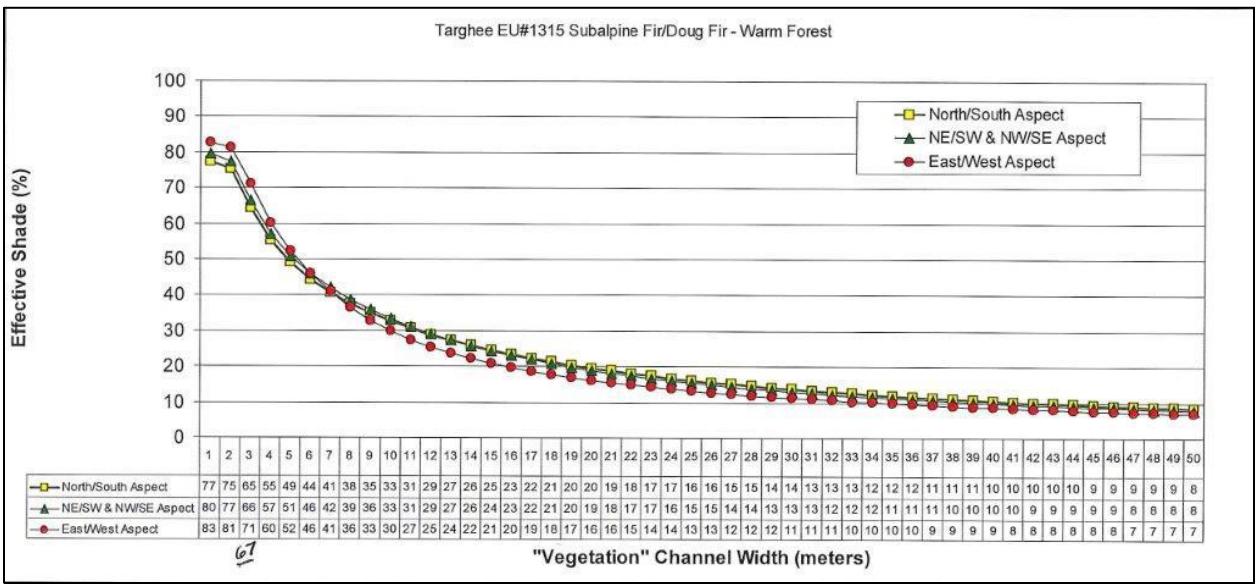
Shade Curves used for Target Shade Analysis



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	87	63	49	41	35	31	27	24	22	20	18	17	16	15	14	13	12	12	11	11	10	10	9	9	8
NE/SW & NW/SE Aspect	87	60	46	37	31	27	23	21	19	17	16	14	13	12	12	11	10	10	9	9	8	8	8	7	7
East/West Aspect	91	51	35	27	22	19	16	14	13	12	11	10	9	8	8	7	7	7	6	6	6	5	5	5	5

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	8	8	8	7	7	7	7	6	6	6	6	6	6	5	5	5	5	5	5	5	5	5	4	4	4
NE/SW & NW/SE Aspect	7	7	6	6	6	6	6	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4
East/West Aspect	5	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2

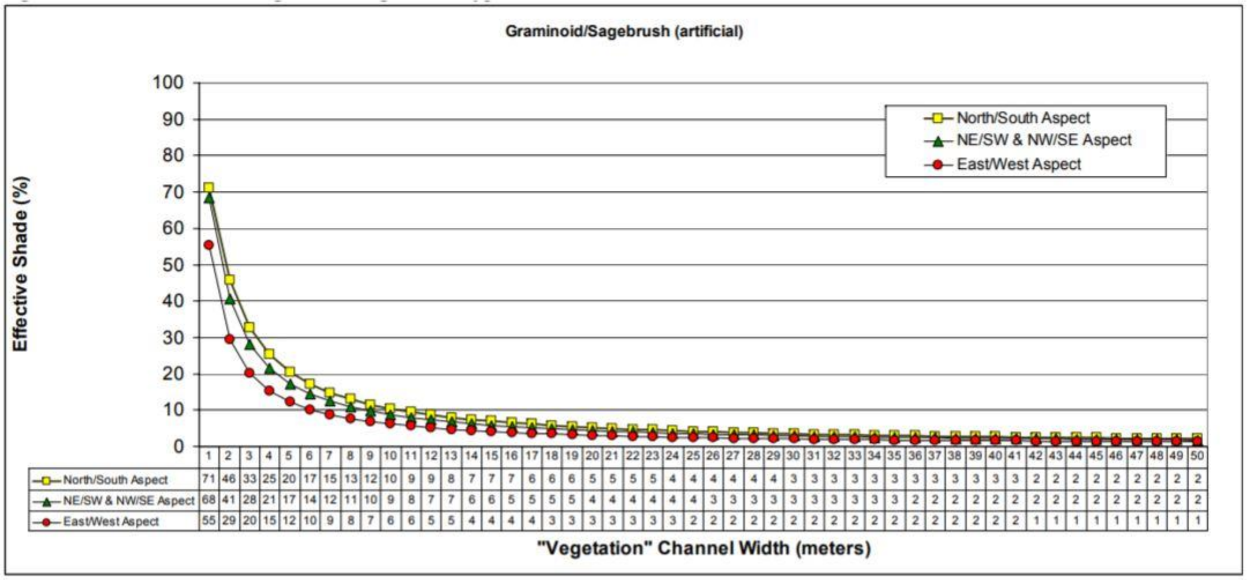
Figure C8. Willow/Graminoid riparian vegetation type #2606.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	77	75	65	55	49	44	41	38	35	33	31	29	27	26	25	23	22	21	20	20	19	18	17	17	16
NE/SW & NW/SE Aspect	80	77	66	57	51	46	42	39	36	33	31	29	27	26	24	23	22	21	20	19	18	17	17	16	15
East/West Aspect	83	81	71	60	52	46	41	36	33	30	27	25	24	22	21	20	19	18	17	16	16	15	14	14	13

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	16	15	15	14	14	13	13	13	12	12	12	11	11	11	10	10	10	10	10	9	9	9	9	9	8
NE/SW & NW/SE Aspect	15	14	14	13	13	13	12	12	12	11	11	11	10	10	10	10	9	9	9	9	9	8	8	8	8
East/West Aspect	13	12	12	12	11	11	11	10	10	10	10	9	9	9	9	8	8	8	8	8	8	7	7	7	7

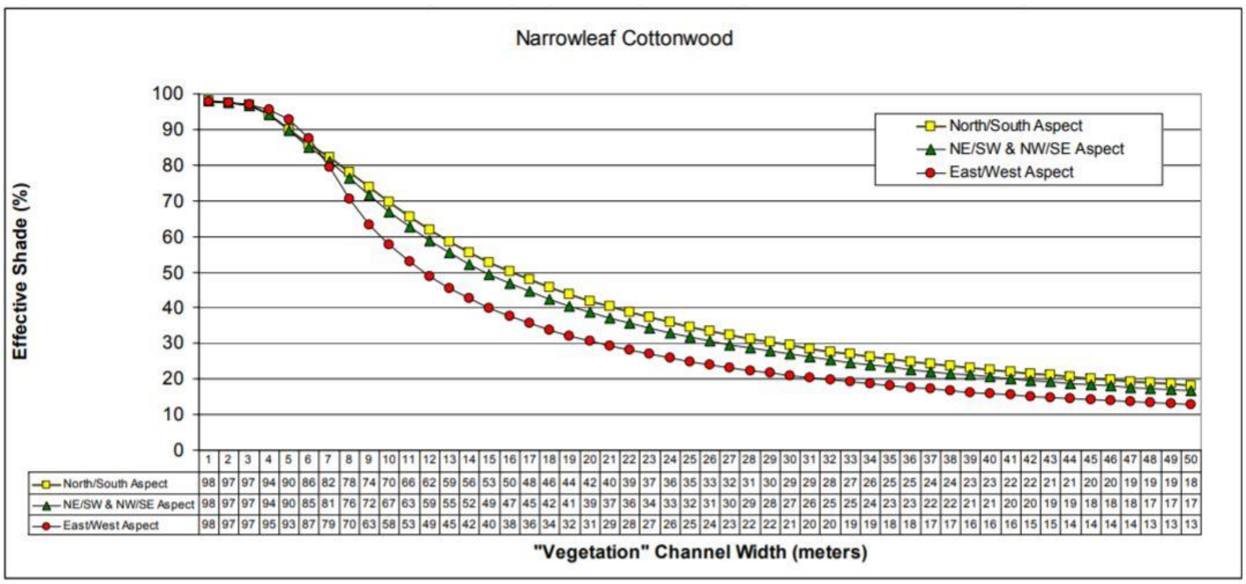
Figure C9. Warm Forest vegetation type #1315.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	71	46	33	25	20	17	15	13	12	10	9	9	8	7	7	7	6	6	6	5	5	5	5	4	4
NE/SW & NW/SE Aspect	68	41	28	21	17	14	12	11	10	9	8	7	7	6	6	5	5	5	5	4	4	4	4	4	4
East/West Aspect	55	29	20	15	12	10	9	8	7	6	6	5	5	4	4	4	4	3	3	3	3	3	3	3	2

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2
NE/SW & NW/SE Aspect	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
East/West Aspect	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1

Figure C10. Graminoid/Sagebrush vegetation type.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	98	97	97	94	90	86	82	78	74	70	66	62	59	56	53	50	48	46	44	42	40	39	37	36	35
NE/SW & NW/SE Aspect	98	97	97	94	90	85	81	76	72	67	63	59	55	52	49	47	45	42	41	39	37	36	34	33	32
East/West Aspect	98	97	97	95	93	87	79	70	63	58	53	49	45	42	40	38	36	34	32	31	29	28	27	26	25

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	33	32	31	30	29	29	28	27	26	25	25	24	24	23	23	22	22	21	21	20	20	19	19	19	18
NE/SW & NW/SE Aspect	31	30	29	28	27	26	25	25	24	23	23	22	22	21	21	20	20	19	19	18	18	18	17	17	17
East/West Aspect	24	23	22	22	21	20	20	19	19	18	18	17	17	16	16	16	15	15	14	14	14	14	13	13	13

Figure C11. Narrowleaf Cottonwood vegetation type.

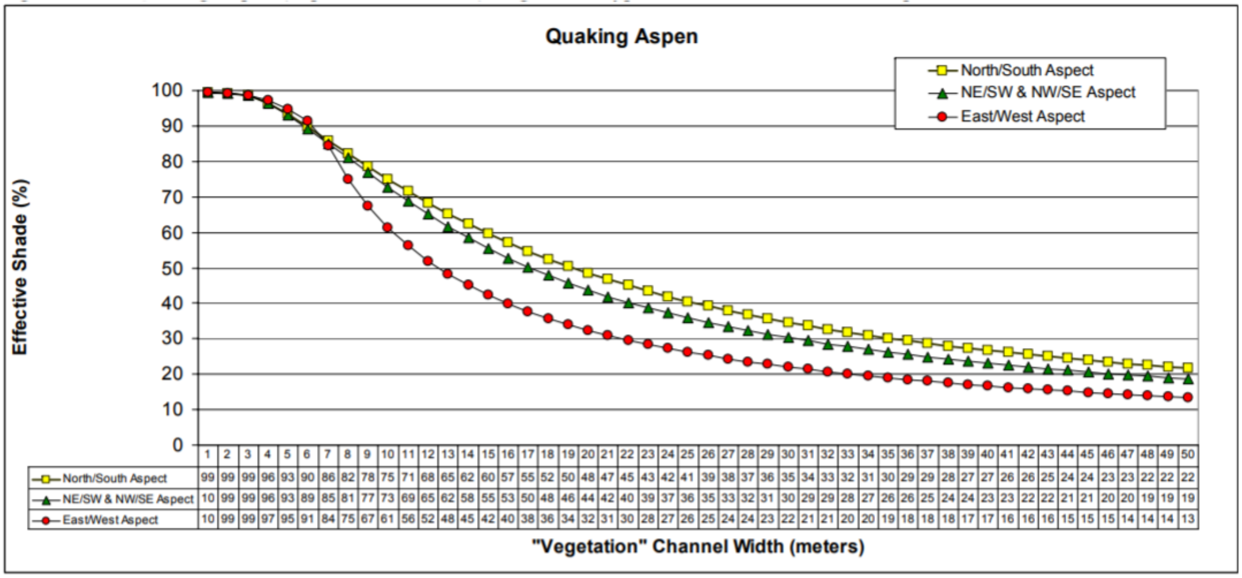


Figure C12. Quaking Aspen vegetation type.

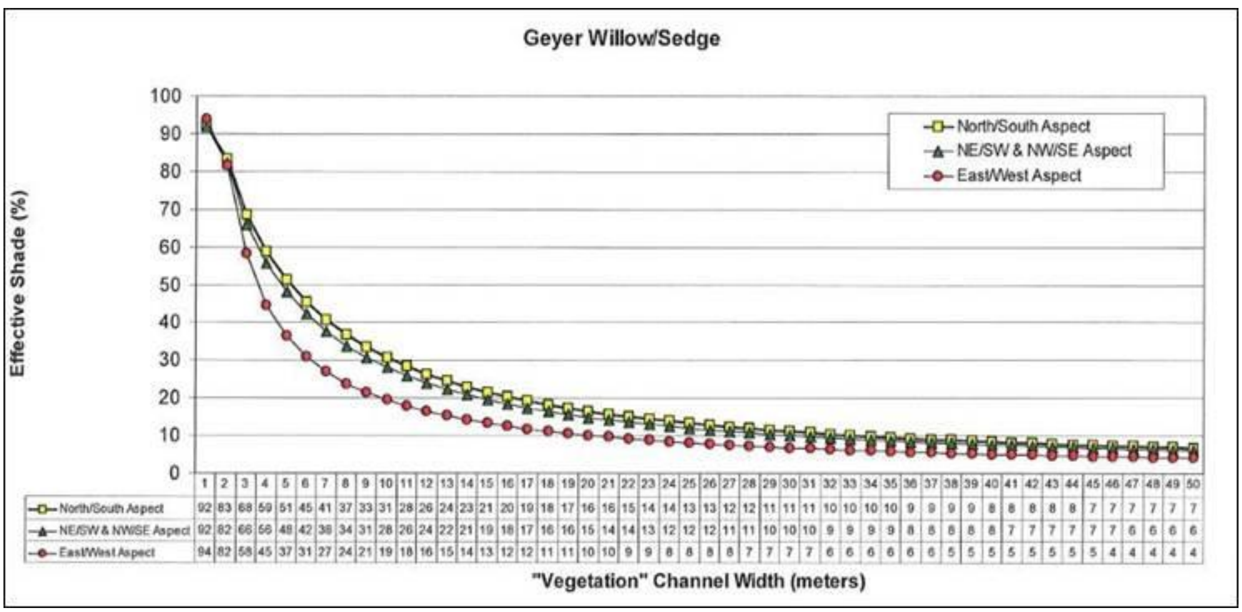


Figure C13. Geyer Willow (*Salix geyeriana*)/Sedge vegetation type.

Appendix D. Managing Stormwater

Municipal Separate Storm Sewer Systems

Polluted stormwater runoff is commonly transported through municipal separate storm sewer systems (MS4s), from which it is often discharged untreated into local water bodies. An MS4, according to 40 CFR 122.26(b)(8), is a conveyance or system of conveyances that meets the following criteria:

- Owned by a state, city, town, village, or other public entity that discharges to waters of the US
- Designed or used to collect or convey stormwater (including storm drains, pipes, ditches, etc.)
- Not a combined sewer
- Not part of a publicly owned treatment works (sewage treatment plant)

To prevent harmful pollutants from being washed or dumped into an MS4, operators must obtain an National Pollutant Discharge Elimination System (NPDES) permit from the US Environmental Protection Agency (EPA), implement a comprehensive municipal stormwater management program (SWMP), and use best management practices (BMPs) to control pollutants in stormwater discharges to the maximum extent practicable.

Industrial Stormwater Requirements

Stormwater runoff picks up industrial pollutants and typically discharges them into nearby water bodies directly or indirectly via storm sewer systems. When facility practices allow exposure of industrial materials to stormwater, runoff from industrial areas can contain toxic pollutants (e.g., heavy metals and organic chemicals) and other pollutants such as trash, debris, and oil and grease. This increased flow and pollutant load can impair water bodies, degrade biological habitats, pollute drinking water sources, and cause flooding and hydrologic changes, such as channel erosion, to the receiving water body.

Multi-Sector General Permit and Stormwater Pollution Prevention Plans

In Idaho, if an industrial facility discharges industrial stormwater into waters of the US, the facility must be permitted under EPA's most recent Multi-Sector General Permit (MSGP). To obtain an MSGP, the facility must prepare a stormwater pollution prevention plan (SWPPP) before submitting a notice of intent for permit coverage. The SWPPP must document the site description, design, and installation of control measures; describe monitoring procedures; and summarize potential pollutant sources. A copy of the SWPPP must be kept on site in a format that is accessible to workers and inspectors and be updated to reflect changes in site conditions, personnel, and stormwater infrastructure.

Industrial Facilities Discharging to Impaired Water Bodies

Any facility that discharges to an impaired water body must monitor all pollutants for which the water body is impaired and for which a standard analytical method exists (40 CFR Part 136).

Also, because different industrial activities have sector-specific types of material that may be exposed to stormwater, EPA grouped the different regulated industries into 29 sectors, based on their typical activities. Part 8 of EPA's MSGP details the stormwater management practices and monitoring that are required for the different industrial sectors. DEQ anticipates including specific requirements for impaired waters as a condition of the 401 certification. The MSGP will detail the specific monitoring requirements.

TMDL Industrial Stormwater Requirements

When a stream is on Idaho's §303(d) list and has a TMDL developed, DEQ may incorporate a wasteload allocation for industrial stormwater activities under the MSGP. However, most load analyses developed in the past have not identified sector-specific numeric wasteload allocations for industrial stormwater activities. Industrial stormwater activities are considered in compliance with provisions of the TMDL if operators obtain an MSGP under the NPDES program and implement the appropriate BMPs. Typically, operators must also follow specific requirements to be consistent with any local pollutant allocations. The next MSGP will have specific monitoring requirements that must be followed.

Construction Stormwater

The CWA requires operators of construction sites to obtain permit coverage to discharge stormwater to a water body or municipal storm sewer. In Idaho, EPA has issued a general permit for stormwater discharges from construction sites.

Construction General Permit (CGP) and Stormwater Pollution Prevention Plans

If a construction project disturbs more than 1 acre of land (or is part of a larger common development that will disturb more than 1 acre), the operator is required to apply for a CGP from EPA after developing a site-specific SWPPP. The SWPPP must provide for the erosion, sediment, and pollution controls they intend to use; inspection of the controls periodically; and maintenance of BMPs throughout the life of the project. Operators are required to keep a current copy of their SWPPP on site or at an easily accessible location.

TMDL Construction Stormwater Requirements

When a stream is on Idaho's §303(d) list and has a TMDL developed, DEQ may incorporate a gross wasteload allocation for anticipated construction stormwater activities. Most loads developed in the past did not have a numeric wasteload allocation for construction stormwater activities. Construction stormwater activities are considered in compliance with provisions of the TMDL if operators obtain a CGP under the NPDES program and implement the appropriate BMPs. Typically, operators must also follow specific requirements to be consistent with any local pollutant allocations. The CGP has monitoring requirements that must be followed.

Postconstruction Stormwater Management

Many communities throughout Idaho are currently developing rules for postconstruction stormwater management. Sediment is usually the main pollutant of concern in construction site stormwater. DEQ's *Catalog of Stormwater Best Management Practices for Idaho Cities and*

Counties (DEQ 2005b) should be used to select the proper suite of BMPs for the specific site, soils, climate, and project phasing in order to sufficiently meet the standards and requirements of the CGP to protect water quality. Where local ordinances have more stringent and site-specific standards, those are applicable.

Appendix E. Pollutant Trading

Pollutant trading (also known as water quality trading) is a contractual agreement to exchange pollution reductions between two parties. Pollutant trading is a business-like way of helping to solve water quality problems by focusing on cost-effective, local solutions to problems caused by pollutant discharges to surface waters. Pollutant trading is one of the tools available to meet reductions called for in a TMDL where point and nonpoint sources both exist in a watershed.

The appeal of trading emerges when pollutant sources face substantially different pollutant reduction costs. Typically, a party facing relatively high pollutant reduction costs compensates another party to achieve an equivalent, though less costly, pollutant reduction.

Pollutant trading is voluntary. Parties trade only if both are better off because of the trade, and trading allows parties to decide how to best reduce pollutant loadings within the limits of certain requirements.

Pollutant trading is recognized in Idaho’s water quality standards at IDAPA 58.01.02.055.06. DEQ allows for pollutant trading as a means to meet TMDLs, thus restoring water quality limited water bodies to compliance with water quality standards. DEQ’s *Water Quality Trading Guidance* sets forth the procedures to be followed for pollutant trading (DEQ 2016c).

Trading Components

The major components of pollutant trading are trading parties (buyers and sellers) and credits (the commodity being bought and sold). Ratios are used to ensure environmental equivalency of trades on water bodies covered by a TMDL. All trading activity must be recorded in the trading database by DEQ or its designated party.

Both point and nonpoint sources may create marketable credits, which are a reduction of a pollutant beyond a level set by a TMDL:

- Point sources create credits by reducing pollutant discharges below NPDES effluent limits set initially by the wasteload allocation.
- Nonpoint sources create credits by implementing approved BMPs that reduce the amount of pollutant runoff. Nonpoint sources must follow specific design, maintenance, and monitoring requirements for that BMP; apply discounts to credits generated, if required; and provide a water quality contribution to ensure a net environmental benefit. The water quality contribution also ensures the reduction (the marketable credit) is surplus to the reductions the TMDL assumes the nonpoint source is achieving to meet the water quality goals of the TMDL.

Watershed-Specific Environmental Protection

Trades must be implemented so that the overall water quality of the water bodies covered by the TMDL is protected. To do this, hydrologically based ratios are developed to ensure trades between sources distributed throughout TMDL water bodies result in environmentally equivalent or better outcomes at the point of environmental concern. Moreover, localized adverse impacts to water quality are not allowed.

Trading Framework

For pollutant trading to be authorized, it must be specifically mentioned within a TMDL document. After adoption of an EPA-approved TMDL, DEQ, in concert with the WAG/BAG, must develop a pollutant trading framework document. The framework would mesh with the implementation plan for the watershed that is the subject of the TMDL. The elements of a trading document are described in DEQ's pollutant trading guidance (DEQ 2016c).

Appendix F. Public Participation and Public Comments

A thirty day public comment period was open from August 31, 2018 through October 1, 2018. During this period the document was viewable on the DEQ website. Public notices of the public comment period were published in the Post Register on August 31, 2018 and the Jefferson Star on September 5, 2018.

Appendix G. Distribution List

Copies of the final document will be provided to the Idaho Department of Environmental Quality State Office and the following agencies, groups, and individual(s):

Government Agencies

Jeremy Casterson, Bureau of Land Management, Upper Snake Field Office

Monica Zimmerman, Bureau of Land Management, Upper Snake Field Office

Jayshika Ramrakha, Environmental Protection Agency, Region 10

Brett High, Idaho Department of Fish and Game, Upper Snake Region

Brian Reed, Idaho Soil and Water Conservation Commission, Idaho Falls

Lee Mabey, United States Forest Service, Caribou Targhee National Forest

Louis Wasniewski, United States Forest Service, Caribou Targhee National Forest

Upper Snake Basin Advisory Group

Matt Woodard (Environment)

Justin Hays (Recreation)

Brian Olmstead (Irrigated Agriculture)

Ralph Myers (Hydropower)

Roger Blew (Representative-At-Large)

Greg Shenton (Local Government)

Hunter Osborne (Shoshone-Bannock Tribes)

Burl Ackerman (Mining)

Richard Savage (Livestock)

Laurie Stone (Forestry)

Steve Lindberg (Non-Municipal Permittee)

South Fork Watershed Advisory Group (defunct)

Mark Lovell, Previous Chair